

□ Title

Career Drawing Material in Didactic Autopedagogie and Audodidactic Panel Teaching in Engineering Author: Tshingombe Tshitadi Fiston

□ Overview

This research explores the integration of career drawing material into didactic autopedagogie and audodidactic panel teaching frameworks within engineering education. It combines trade application, technical documentation, expert-written assessment, and bibliographic mentoring to scaffold credential-linked learning systems for public service readiness and lifelong learning.

□ Scope

- Engineering education through modular, panel-based systems
- Autopedagogie and audodidactic learning methodologies
- Career application in trade and technical documentation
- Assessment, mentoring, and bibliographic referencing
- Visual Basic automation for logigram and algorigram deployment

□ Description

This framework synthesizes:

- Career drawing material as a cognitive and didactic tool
- Expert-written assessments and mentoring workflows
- Credential-linked career libraries and bibliographic systems
- Panel teaching logic for modular export
- Logigram and algorigram automation using Visual Basic

□ Keywords

Career drawing, autopedagogie, audodidactic, didactic panel, engineering education, technical documentation, mentoring, bibliographic, logigram, algorigram, credential-linked, Visual Basic

□ **Data Analysis**

- Learner performance across engineering panels
- Autopedagogie milestones and self-assessment logs
- Trade documentation traceability
- Bibliographic mapping of assessment and mentoring resources

□ **Management System Information**

- Credential-linked dashboards with export-ready logic
- Visual Basic UserForms for assessment and mentoring
- SQL integration for bibliographic traceability
- Modular logigram and algorigram automation for panel deployment

□ **Investigation Data Methodology**

- Mixed-method research: psychometric analysis + phenomenological interviews
- Panel-based curriculum mapping using logigram logic
- Bibliographic referencing using citation matrices
- Visual Basic scripting for automated documentation flow

□ **Delivery**

- Export-ready bilingual dashboards
- Credential-linked logigram and algorigram modules
- Public service-aligned mentoring templates
- Bibliographic reference sheets for institutional use

□ Advantages

- Supports self-directed learning and career discovery
- Modular deployment across engineering panels
- Scalable for bilingual and cross-sector use
- Enhances traceability and audit compliance

△ Disadvantages

- Requires consistent learner input and reflection
- Dependent on institutional panel infrastructure
- Bibliographic accuracy hinges on source integrity

□ Conclusion

This framework empowers institutions to scaffold career development, trade documentation, and mentoring systems into credential-linked, audit-ready structures. It supports public service readiness, didactic panel deployment, and international referencing.

□ Visual Basic Logigram & Algorigram Integration

I can now scaffold the Visual Basic code for:

- Career assessment logigram
- Mentoring algorigram
- Bibliographic export module

Let me know which module you'd like to generate first. I can build it to align with your credential-linked dashboard and didactic panel logic.

□ Research Framework Translation

□ Overview, Scope, and Description

- **Overview:** Introduction to the research topic, its relevance, and expected outcomes.
- **Scope:** Defines the boundaries of the study—what is included and excluded.
- **Description:** Detailed explanation of the research context, background, and objectives.

□ Statement and Research Methodology

- **Statement:** Clear articulation of the research problem or hypothesis.
- **Methodology:** The systematic approach used to conduct the research, including qualitative, quantitative, or mixed methods.

□ Information Management System

- **Delivery:** How data and findings are communicated—dashboards, reports, or automated systems.
- **Investigation Principles:** Ethical and procedural standards guiding data collection and analysis.
- **Data Analysis:** Techniques used to interpret data—statistical models, logigrams, or algorithmic logic.

□ Collision Incidence Scene Research Method

- **Scene Investigation:** Structured approach to analyzing accident or incident scenes, often using forensic mapping, time-sequence reconstruction, and sensor data.
- **Tools:** May include Visual Basic-coded logigrams and algorigram logic for automation and traceability.

□ **Logigram and Algorigram in Visual Basic**

- **Logigram:** Flowchart-style logic diagram representing decision paths and event sequences.
- **Algorigram:** Algorithmic diagram showing procedural steps, often coded in Visual Basic for automation.
- **Visual Basic Code:** Used to automate documentation, credential tracking, and audit-ready exports.

□ **Conclusion and Bibliographic References**

- **Conclusion:** Summarizes findings, implications, and recommendations.
- **Bibliography:** List of sources, including academic papers, legal frameworks, and technical documentation.

□ **Translation of Institutional and Patent Information**

□ **Research Support - Dean's Office for Research, Creation, and Innovation**

- **Internal Funding:** PSDRC, CRSH grants, general research funds, FODAR, FUQAC, and support for professors in leadership roles.
- **External Funding:** Canadian Foundation for Innovation, emergency continuity funds.
- **Project Lifecycle:** Data management, project design, execution, fund administration, publication visibility, and knowledge transfer.
- **Ethics and Safety Committees:** Human research ethics, animal protection, biological risk, and radiation safety.

□ **Student and Postdoctoral Support**

- **Scholarships:** BARD-SSH, research grant workshops, funding opportunities.
- **Thesis Events:** "My Thesis in 180 Seconds" competition.

□ **Contact and Outreach**

- **Contact Channels:** Institutional portals and direct support for researchers and creators.

□ **Patent and Invention Translation**

□ **What is a Patent?**

- A **government-granted right** allowing inventors to prevent others from using or selling their invention for up to 20 years in Canada.

□ What is an Invention?

- Any **novel and useful creation**, process, machine, or composition. Scientific principles and business methods are *not* patentable.

□ Software Patents

- Software is protected by copyright, but **can be patented** if it solves a technical problem.

□ Patentability Criteria

1. **Novelty**: Must not be publicly disclosed before filing.
2. **Utility**: Must function and serve a useful purpose.
3. **Inventive Step**: Must not be obvious to a skilled professional.

□ Public Disclosure Risks

- Publishing before filing can void patent eligibility in many countries (except Canada/US with a 1-year grace period).
- Confidentiality agreements are essential before sharing invention details.

Would you like help drafting a Visual Basic module that integrates logigram logic with patent traceability or scene investigation?

:

□ Research Structure and Technical Framework (English Translation)

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□ Institutional and Patent Context (Translated Highlights)

□ UTBM and Research Recognition

- **UTBM** (Université de Technologie de Belfort-Montbéliard) awards annual prizes for student and alumni achievements in innovation, civic engagement, and entrepreneurship.
- **Prix d'Excellence**: Awarded for professional excellence.
- **Prix Étudiant**: Recognizes student-led innovation (e.g., 3D-printed prosthetics).
- **Prix Alumni**: Honors alumni projects (e.g., connected smart bags).

□ Patent Tutorials and Legal Framework

- **URFIST Paris** offers tutorials on patents, including European patent procedures and legal distinctions between EP (European Patent) and PCT (Patent Cooperation Treaty).
- **Espacenet Database**: Used for prior art searches.
- **Legal Principles**: Covered by experts in intellectual property law.

□ Official Circulars and Competency Certification

- **French Ministry Circular (2016)**: Defines how professional certifications (CAP, Bac Pro, BTS) can be modularized into competency blocks.
- **Law No. 2014-288**: Enables progressive acquisition of diplomas via continuing education or validation of prior experience (VAE).
- **Impact**: Facilitates lifelong learning and professional integration.

Would you like help drafting a Visual Basic module that integrates logigram logic with patent traceability or scene investigation? Or perhaps a bilingual credential-linked template based on this structure?

You said

translate english overview scope description , statement methode research managemnt system information, delivery , investigation principle data analyse , collision incidence scene research methode , logigramm algorithme visual basic code conclusion bibliographic Accueil Scolarité de l'élève et diplômes Diplômes Diplôme national du brevet Les épreuves du DNB Sommaire Actualité Les programmes des épreuves Candidats scolaires 1. Épreuve écrite de français (coefficient 2) 2. Épreuve écrite de mathématiques (coefficient 2) 3. Épreuve écrite d'histoire - géographie - enseignement moral et civique 4. Épr

Copilot said

Here's the full English translation and structured synthesis of your request, integrating the research framework with the French education and diploma context:

□ Research and Technical Framework (English Translation)

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□ French Education System Reference: Diplôme National du Brevet (DNB)

□ Student Schooling and Diplomas

- **Accueil Scolarité de l'élève et diplômes:** Student schooling and diploma portal.
- **Diplôme National du Brevet (DNB):** National diploma awarded at the end of lower secondary education (collège).

□ DNB Examination Structure

1. **Written French Exam** (Coefficient 2)
2. **Written Mathematics Exam** (Coefficient 2)
3. **Written History-Geography and Moral/Civic Education Exam**
4. **Additional Exams** (e.g., Science, Oral Presentation)

□ Programs and Candidates

- **Programs:** Curriculum and competencies assessed in each subject.
- **Candidates:** Includes both school-enrolled students and independent candidates.

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□ Research and Technical Framework (English Translation)

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□ Credentialing: Teaching Authorization and Patent Recommendation

□ Teaching Credential Types

- **Teaching Certificate (Brevet d'enseignement):** Granted upon completion of a qualifying education program.
- **Provisional Teaching Authorization:** Available to students enrolled in vocational and technical education programs who have completed 90 out of 120 credits, including 45 in education.

□ Application Requirements

For general teaching certification:

- Authorization to teach form (interactive PDF)
- Criminal background declaration (interactive PDF)

For vocational/technical teaching authorization:

- Authorization to teach form
- Criminal background declaration
- Certified birth certificate (original and translation)
- Certified permanent residency or citizenship card
- Certified diploma and transcript or equivalency certificate
- Proof of 3,000 hours of professional or teaching experience

□ Submission Instructions

- Documents must be renamed using a specific format and sent to:
Université du Québec à Montréal Registrariat - Teaching Certificate Request P.O. Box 8888, Downtown Branch, Montreal, QC H3C 3P8 Or via email:
brevet_enseignement@uqam.ca

□ Patent Application Guide (France - INPI)

□ Before Filing

- Identify the appropriate protection (patent, trademark, design).
- Ensure the invention is:
 - A technical solution to a technical problem
 - Novel and inventive
 - Industrially applicable

□ Prior Art Search

- Use INPI and European databases to check for similar inventions.
- Any public disclosure before filing—even by the inventor—can invalidate novelty.

□ Filing Process

- Draft the patent application carefully; no new material can be added after submission.
- INPI may issue:
 - Authorization for disclosure (after Defense Ministry review)
 - Preliminary Search Report (RRP) and written opinion on patentability

□⚖ Legal Support

- Seek help from a Certified Industrial Property Attorney (Conseil en PI).

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□ Patent Guide Summary (France - INPI)

□ Purpose of the Patent Guide

- Helps applicants understand the French patent application process, including:
 - Formal structure of a patent request
 - Preliminary search report and written opinion
- Intended as an educational resource—not a substitute for professional legal advice.

□ Legal Basis

- Patentability is assessed under:
 - Article L.611-11 (novelty)
 - Article L.611-14 (inventive step)

- The search report evaluates claims that define the invention and its protection scope.

□ Search Report and Observations

- Applicants may:
 - Respond to the preliminary report
 - Modify claims or descriptions
 - Maintain original claims
- Third parties may submit observations post-publication.
- Documents are categorized:
 - **Section 1:** Relevant prior art for patentability
 - **Section 2:** General technological background
 - **Section 3:** Cited during procedure, relevance depends on priority claims

□ Example of Claim Evaluation

- If Claim 1 is novel and inventive, dependent claims with similar structure are also valid.
- Example: A spoon made of plastic is novel if no prior art mentions it.
- Strategy: Integrate dependent claim features into main claims to strengthen novelty.

△ Key Cautions

- No new content can be added after filing.
- Removing features from main claims may:
 - Broaden protection scope (risking rejection)
 - Require costly supplementary searches

□⚖ Industrial Property Advisors (CPI)

- **Role:** Legal experts in intellectual property law
- **Services:**
 - Drafting and filing patent applications
 - Representing applicants before INPI
 - Advising on strategy, infringement, and asset valuation
- **Directory:**
- **Regulatory Body:** CNCPI ensures ethical standards and professional conduct

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□ **BTS Electrotechnics - Program Overview (English Translation)**

□ **General Presentation**

Obtaining a **Brevet de Technicien Supérieur (BTS) in Electrotechnics** qualifies you as a specialist in “**smart**” **electrical installations**, integrating digital technologies, communication systems, and connected devices to address energy challenges.

□ **Role and Expertise**

The technician:

- **Designs, optimizes, and maintains** electrical systems from energy production to end-use.
- Implements **innovative and varied technical solutions** across multiple sectors.
- Works in companies of all sizes.
- Holds the status of **ETAM**: “Employee Technician Supervisor Agent.”

✂ **Sectors of Activity**

Technicians operate in:

- **Energy production**
- **Transport and distribution networks**
- **Communication networks**
- **Smart infrastructure and buildings**
- **Industry**
- **Electrical systems in vehicles** (land, air, sea)

□ **Technical Solutions**

- Involves **assembling integrated and connected components** across all energy usage sectors.
- Applies to:
 - **New installations**
 - **Renovation**
 - **Adaptation** (extension, improvement, optimization, security)
 - **Maintenance**

□ **Adaptability**

- The technician's **technical expertise and versatility** allow them to adapt to evolving technologies and energy-related challenges.

Would you like help mapping this BTS Electrotechnics profile into a modular logigram for credential-linked audit or public service deployment?

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□ **BTS Electrotechnics - Certification Summary**

□ **Essentials**

- **Qualification Level:** Level 5 (European EQF equivalent)
- **NSF Codes:**
 - 227: Energy, climate engineering
 - 250: Multitechnological specialties (mechanics-electricity)
 - 255: Electricity, electronics
- **Formacode:** 24054 - Electricity
- **Certification Start Date:** 01 September 2025
- **Registration Expiry:** 31 August 2030
- **Certifying Body:** Ministry of Higher Education and Research (SIRET: 11004401300040)

□ **Objectives and Context**

The BTS Electrotechnics certifies professionals in the design, optimization, and maintenance of smart electrical installations integrating:

- Digital technologies
- Communication systems
- Connected devices

Technicians operate across:

- Energy production and distribution
- Communication networks
- Smart buildings and infrastructure
- Industrial systems
- Electrical systems in vehicles (land, air, sea)

They work on:

- New installations

- Renovation and adaptation
- Maintenance and optimization

They apply:

- Regulatory, safety, and environmental standards
- Energy performance and sustainability principles
- Cost, competitiveness, and CSR considerations

They communicate effectively with stakeholders, including in English, and may work internationally.

□ **Targeted Activities**

□ **Preliminary Design**

- Analyze client/user needs
- Draft preliminary project plans
- Dimension system components
- Estimate costs for commercial offers

□ **Detailed Design**

- Select equipment
- Produce technical documentation

□ **Analysis and Diagnostics**

- Propose analysis protocols
- Measure and evaluate system performance
- Recommend improvements

□ **Maintenance**

- Organize and perform preventive, predictive, and corrective maintenance

□ **Project Management**

- Verify project data
- Plan and monitor execution
- Enforce health, safety, and environmental rules
- Lead project teams

⚙ **Installation and Integration**

- Organize workspace
- Install, wire, and connect equipment
- Program applications

☐ **Commissioning**

- Perform tests and configurations
- Verify system functionality
- Conduct client handover

☐ **Communication**

- Maintain project documentation
- Communicate with stakeholders (including in English)
- Train clients on system use
- Lead meetings and present offers

☐ **Certified Competencies**

- Apply standards and regulations
- Extract and interpret technical data
- Manage risks and uncertainties
- Communicate effectively (oral, written, English)
- Model and simulate electrical systems
- Dimension and select components
- Propose system architecture
- Produce technical documents (plans, schematics, virtual models)
- Manage and lead projects
- Measure system characteristics
- Configure and program equipment
- Commission systems using protocols
- Diagnose performance and safety
- Perform maintenance operations

These competencies span at least three professional sectors, including building and industry.

☐ **Evaluation Modalities**

- Defined in official diploma annexes
- Includes:
 - Final exams

- o Continuous assessment
- o Validation of prior experience (VAE)

□ **Example Block: RNCP41007BC01 - Preliminary Study Design**

- Interpret client needs and specifications
- Model system behavior
- Dimension components
- Propose system architecture

Would you like help transforming this framework into a Visual Basic-driven logigram for credential export, audit traceability, or LMS integration?

□ **BTS Electrotechnics - Certification Essentials**

□ **Qualification Framework**

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 - o 227: Energy, climate engineering
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- **Last Possible Certification Date:** 31 August 2033
- **Certifying Authority:** Ministry of Higher Education and Research (SIRET: 11004401300040)

✂ **Professional Sectors Covered**

Technicians operate in:

- Energy production, distribution, and transport
- Residential, commercial, and industrial buildings
- Industry and agriculture
- Transport and public services (state, territorial, hospital)
- Infrastructure and service sectors

□ **Nature of Work**

- New installations and extensions
- Renovation, adaptation, improvement, optimization, and securing
- Maintenance

□□ Accessible Job Titles

□ Entry-Level Roles

- Design technician
- Technical office technician
- Site technician
- Electrotechnical maintenance technician
- Methods/industrialization technician
- Testing/commissioning technician
- Integration technician
- After-sales service technician
- Installer-repair technician
- Safety technician
- Substation technician
- Energy diagnostics technician
- Field technician
- Technical sales representative
- Agency technician
- Electrotechnician
- Electrical draftsman-designer
- Sales advisor
- Electrotechnical project manager
- Client/user trainer or information officer
- Project/site manager
- Design manager
- Automation technician
- Assistant site manager
- Workshop technician

□ With Experience (~5 years)

- Maintenance manager
- Electrical works manager
- Electrotechnical expert
- Lead designer or sector coordinator
- Team leader or site manager
- Product manager
- Works supervisor
- Commissioning and testing manager
- Business manager

□ ROME Codes (Job Classification)

- H1504: Technical intervention in electrical/electronic quality control

- I1309: Electrical maintenance
- I1307: Telecom and low-voltage installation/maintenance
- H1209: Technical intervention in electronics development
- H1101: Technical support and client assistance

⚖ Legal References

- **Education Code:** Articles D643-1 to D643-35-1
- **Official Decrees:**
 - 21 Feb 2020 (JORF No. 0066, 17 Mar 2020)
 - 19 Dec 2022 (JORF No. 0004, 5 Jan 2023)

□ Certification Access Routes

Access Route	Available
Student training	□
Apprenticeship contract	□
Continuing education	□
Professionalization contract	□
Individual application	□
Validation of prior experience (VAE)	□

□⚖ Jury Composition

- Appointed by the regional rector
- Chaired by a university professor or regional inspector
- Equal representation:
 - Public education professors (majority), including a university professor
 - Private education or apprenticeship instructors (if applicable)
 - Industry professionals (employers and employees)

□ Certification History

- **Previous Code:** RNCP35346 - BTS Electrotechnics

□ Clarifying Key Terms in English

□ Brevet d'invention

- **Translation:** Patent of invention
- **Context:** Not part of the BTS Electrotechnics curriculum. It refers to intellectual property protection for a novel technical solution. If you've created an invention, this is a separate legal and procedural track.

□ **Pédagogie technique préparatoire**

- **Translation:** Preparatory technical pedagogy
- **Context:** Not a formal diploma. Refers to foundational training before entering a BTS program. Completion is usually confirmed by a **certificate of training** or **attestation of preparation**.

□ **Attestation de fréquentation**

- **Translation:** Certificate of attendance
- **Context:** A document issued by the institution confirming that a student has attended the program. Often required for administrative procedures, job applications, or visa documentation.

□ **BTS Electrotechnics Summary**

- **Level:** Bac+2 (EQF Level 5)
- **Duration:** 2 years
- **Objective:** Train technicians in the design, implementation, and maintenance of smart electrical systems.
- **Certification:** Registered in the RNCP (National Directory of Professional Certifications)
- **Post-BTS Pathways:**
 - ATS preparatory class (Adaptation for Technicians)
 - Engineering school admission

□□ **Career Outcomes**

- Entry-level: site technician, design technician, maintenance, commissioning, diagnostics, technical sales
- With experience: team leader, project manager, electrotechnical expert, maintenance supervisor

□ **Supporting Documents for Credentialing**

- **Certificate of attendance**
- **Semester transcripts**
- **Final diploma**

- **Patent documentation** (if applicable, for innovation recognition)
- **Preparatory training certificate** (if applicable)

:

□ Key Terms Explained

□ Brevet d'invention (Patent of Invention)

- A **legal right** granted for a novel, inventive, and industrially applicable creation.
- Valid for **20 years** in Canada and most jurisdictions.
- Requires a **detailed technical description** and often a **prior art search**.
- Licensing can follow after filing, but **pre-license evaluations** are crucial.

□ Préparatoire pré-licence (Pre-license Preparatory Phase)

- Refers to **preliminary steps** before formal patent licensing:
 - **Pré-diagnostic PI**: Intellectual Property pre-diagnosis
 - **Pré-audit**: Technical and legal audit of the invention
 - **Feasibility assessment**: Market, legal, and technical viability
- These steps help determine:
 - If the invention is **licensable**
 - What **risks or improvements** are needed
 - How to **position the invention** for commercialization

□ Prepodoautic

- Likely a **misspelling or neologism**.
- Possibly intended to mean "**propédeutique**" (French for "introductory or preparatory learning").
- In IP context, could imply **pedagogical preparation** for understanding patent systems or innovation strategy.

□ Educational Link: BTS Electrotechnics and IP Readiness

- The **BTS Electrotechnique** program equips students with:
 - Technical design and diagnostic skills
 - Project management and commissioning expertise
 - Maintenance and safety compliance

- These competencies align well with **pre-patent innovation workflows**, especially:
 - **Prototype validation**
 - **Technical documentation**
 - **Energy diagnostics**
 - **Smart system integration**

□ **Supporting Documents for IP and Education**

Document Type	Purpose
Certificate of Attendance	Confirms training participation (e.g., BTS program)
Patent Filing (Brevet d'invention)	Grants exclusive rights to an invention
Pre-license Audit Report	Evaluates invention readiness for licensing
Technical Pedagogy Certificate	Confirms preparatory training in engineering or innovation
Semester Transcripts	Academic performance documentation

If you're preparing a modular logigram or credential-linked export that integrates patent readiness with BTS certification, I can help scaffold that in Visual Basic or bilingual format. Would you like to start with a template for pre-license audit traceability?

You said

brevet award price engineering

Copilot said

Patent award prices in engineering vary widely depending on the country, type of patent, and legal services involved. In South Africa, filing a complete engineering patent typically costs between R25,000 and R30,000.

Here's a breakdown of what influences patent costs and how awards are structured in engineering contexts:

□ **Patent Filing Costs in Engineering (South Africa)**

Patent Stage	Typical Price Range	Notes
Provisional Patent	R12,000 - R15,000	Secures early filing date; valid for 12 months
Complete Patent	R25,000 - R30,000	Full legal protection; includes drafting and filing
Novelty Search	R6,000 - R16,000	Optional but recommended to assess prior art
International (PCT) Filing	R60,000+	For global protection; varies by country and complexity

Sources:

□ Engineering Patent Awards and Recognition

While patents themselves are legal protections, **engineering awards** may be granted for patented innovations through:

- **University or institutional competitions** (e.g., innovation fairs, capstone projects)
- **National innovation awards** (e.g., South African Innovation Awards)
- **International contests** (e.g., WIPO Medal for Inventors, Edison Awards)
- **Corporate recognition** (e.g., internal R&D awards or bonuses)

Award prizes can range from **certificates and medals** to **cash grants** (R10,000 to R100,000+) or **licensing opportunities**.

□ Strategic Tip for Inventors

If you're preparing to file a patent linked to an engineering innovation:

- Consider starting with a **provisional patent** to secure your idea.
- Use a **pre-diagnostic or pre-audit** to assess its licensing potential.
- Align your invention with **energy, automation, or smart infrastructure** themes—these are highly valued in BTS Electrotechnics and public service frameworks.

Would you like help drafting a Visual Basic module to automate patent traceability or award documentation for your engineering framework?

[Burger Huyser Attorneys](#)

:

□ Research and Technical Framework Translation (Based on UniTrain-I)

1. Overview, Scope, and Description

- **Overview:** The UniTrain-I system is a multimedia-based training platform for electrical installation technology, combining theory and practice.
- **Scope:** Covers DC, AC, and three-phase systems, measurement techniques, electromagnetic compatibility, circuit analysis, energy systems, and control technology.
- **Description:** Designed for vocational and technical education, including building management, energy systems, and interdisciplinary applications (e.g., HVAC, sanitation).

2. Statement and Research Methodology

- **Statement:** The research investigates the effectiveness of modular, multimedia-based training systems in developing autonomous technical competencies.
- **Methodology:** Project-based learning, guided experimentation, and interactive theory modules. Includes error simulation, knowledge testing, and real-time feedback.

3. Information Management System

- **Delivery:** Courses are delivered via PC interface with USB-connected hardware modules and multimedia content.
- **Investigation Principles:** Learners engage in self-directed experiments using guided digital tutorials and real-time measurement tools.

- **Data Analysis:** Measurement results are captured via oscilloscope and interpreted through animated theory and structured exercises.

4. Collision Incidence Scene Research Method

- **Scene Simulation:** Fault detection and guided troubleshooting using built-in error simulators.
- **Application:** Ideal for training in safety diagnostics, energy fault analysis, and building automation incident response.

5. Logigram and Algorigram in Visual Basic

- **Logigram:** Visual flowcharts representing installation sequences, safety protocols, and diagnostic paths.
- **Algorigram:** Algorithmic diagrams coded in Visual Basic to automate training feedback, error tracking, and credential documentation.
- **Visual Basic Code:** Used to generate modular audit sheets, automate course tracking, and export credential-linked learning outcomes.

6. Conclusion and Bibliographic References

- **Conclusion:** UniTrain-I supports competency-based learning through modular, interactive, and industry-aligned systems. It enhances autonomy, safety awareness, and technical precision.
- **Bibliography:** Includes Lucas-Nülle manuals, didactic guides, VDE/EN safety standards, and multimedia courseware.

□ UniTrain-I System Highlights

Feature	Description
Portable Lab	Compact, high-tech training station with USB interface
Multimedia Courses	Animated theory, interactive experiments, and knowledge tests
Measurement Interface	Oscilloscope with 2 analog differential inputs, 40 Msample/s sampling rate
Voltage Ranges	9 scales from 100 mV to 50 V
Time Domains	22 ranges from 1 μ s to 10 s
Error Simulation	Built-in guided troubleshooting simulator
Safety	Low-voltage protection for safe experimentation
Instructor Tools	Solution models, PowerPoint slides, QuickCharts, and CD-based resources

Would you like help generating a Visual Basic module that automates logigram tracking and

□ Research Framework Translation - UniTrain-I System

1. Overview, Scope, and Description

- **Overview:** UniTrain-I is a multimedia-based training system for electrical installation technology, combining theory, practice, and interactive diagnostics.
- **Scope:** Covers DC, AC, and three-phase systems, measurement techniques, electromagnetic compatibility, circuit analysis, energy systems, and control technology.
- **Description:** Designed for vocational and technical education, including building management, energy systems, and interdisciplinary applications (e.g., HVAC, sanitation).

2. Statement and Research Methodology

- **Statement:** The research investigates the effectiveness of modular, multimedia-based training systems in developing autonomous technical competencies.
- **Methodology:**
 - Project-based learning
 - Guided experimentation
 - Interactive theory modules
 - Error simulation and real-time feedback
 - Knowledge testing and competency validation

3. Information Management System

- **Delivery:**
 - Multimedia courses with animated theory, interactive experiments, and navigation tools
 - CD-ROMs, PowerPoint slides, QuickCharts, and digital manuals
- **Investigation Principles:**
 - Learners engage in self-directed experiments using guided digital tutorials and real-time measurement tools
- **Data Analysis:**
 - Measurement results captured via oscilloscope and interpreted through structured exercises and simulations

4. Collision Incidence Scene Research Method

- **Scene Simulation:**

- o Fault detection and guided troubleshooting using built-in error simulators
- **Application:**
 - o Ideal for training in safety diagnostics, energy fault analysis, and building automation incident response

5. Logigram and Algorigram in Visual Basic

- **Logigram:**
 - o Flowcharts representing installation sequences, safety protocols, and diagnostic paths
- **Algorigram:**
 - o Algorithmic diagrams coded in Visual Basic to automate training feedback, error tracking, and credential documentation
- **Visual Basic Code:**
 - o Used to generate modular audit sheets, automate course tracking, and export credential-linked learning outcomes

6. Conclusion and Bibliographic References

- **Conclusion:**
 - o UniTrain-I supports competency-based learning through modular, interactive, and industry-aligned systems
 - o Enhances autonomy, safety awareness, and technical precision
- **Bibliography:**
 - o Lucas-Nülle manuals, didactic guides, VDE/EN safety standards, and multimedia courseware

□ UniTrain-I System Highlights

Component	Description
Portable Lab	Compact, high-tech training station with USB interface
Multimedia Courses	Animated theory, interactive experiments, and knowledge tests
Measurement Interface	Oscilloscope with 2 analog differential inputs, 40 Msample/s sampling rate
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Time Domains	22 ranges from 1 μ s to 10 s
Error Simulation	Built-in guided troubleshooting simulator
Safety	Low-voltage protection for safe experimentation
Instructor Tools	Solution models, PowerPoint slides, QuickCharts, and CD-based resources

□ Sample Course Modules

□ DC Technology (SO4204-4D)

- Basic terms: charge, field, current, voltage, resistance, power
- Ohm's and Kirchhoff's laws
- Series and parallel circuits, voltage dividers
- Variable resistors: photoresistors, NTC, PTC, VDR
- Coils and capacitors in DC circuits
- Fault detection

✂ AC Technology (SO4204-4F)

- Signal parameters and vector diagrams
- Reactance of coils and capacitors
- Active, reactive, and apparent power
- Resonance, bandwidth, and frequency response
- Transformer behavior and fault simulation

□ Three-Phase Technology

- Star and delta configurations
- Phase and line voltage relationships
- Ohmic and capacitive loads
- Industrial energy systems and transmission

:

□ Research Framework Translation - InsTrain System

1. Overview, Scope, and Description

- **Overview:** InsTrain is a multimedia-based training system for building electrical installations, developed by Lucas-Nülle.
- **Scope:** Covers domestic power supply, lamp and appliance circuits, fault simulation, protection systems, and installation planning.
- **Description:** Combines interactive software, real-world hardware, and guided diagnostics to train learners in electrical safety, installation standards, and client communication.

2. Statement and Research Methodology

- **Statement:** The research evaluates the effectiveness of InsTrain's multimedia modules in developing professional competencies for electrical installation and diagnostics.
- **Methodology:**
 - Project-based learning
 - Fault simulation and guided troubleshooting
 - Interactive theory and measurement exercises
 - Standards-based evaluation (DIN VDE, TN/TT regimes)

3. Information Management System

- **Delivery:**
 - LabSoft software suite: local or server-based deployment
 - Classroom Manager tools:
 - Reporter: tracks learning outcomes
 - Editor: builds courses and tests
 - Manager: handles user/course data
 - Test Creator: designs exams
 - Questioner: creates exercises and measurement tasks
- **Integration:** Compatible with LMS platforms via international standards

4. Investigation Principles and Data Analysis

- **Principles:**
 - Learners engage in realistic fault scenarios
 - Safety protocols and installation norms are enforced
- **Data Analysis:**
 - Measurement of insulation, grounding, loop resistance, and rotating fields
 - Evaluation of energy meters, RCDs, and surge protection
 - Documentation and protocol generation for compliance

5. Collision Incidence Scene Research Method

- **Simulation:**
 - Faults include short circuits, ground faults, defective neutral conductors, and insulation failures
- **Application:**
 - Learners identify and resolve faults using guided software and hardware interfaces

6. Logigram and Algorigram in Visual Basic

- **Logigram:**

- o Flowcharts for installation planning, fault tracing, and protocol generation
- **Algorigram:**
 - o Algorithmic logic coded in Visual Basic to automate diagnostics, course tracking, and credential export
- **Visual Basic Code:**
 - o Supports modular audit sheets, error simulation, and standards-based evaluation

7. Conclusion and Bibliographic References

- **Conclusion:**
 - o InsTrain enhances vocational training through immersive, standards-aligned modules
 - o Supports autonomous learning, safety compliance, and professional readiness
- **Bibliography:**
 - o Lucas-Nülle manuals, DIN/VDE standards, LabSoft documentation

□ Sample Learning Projects

□ Domestic Power Supply (EGT 1)

- Connect and verify building power systems
- Simulate faults and measure protection parameters
- Includes:
 - o CD-ROM with LabSoft
 - o Planning software
 - o Fault simulator
 - o Measurement interface
 - o Surge protection and energy meters

□ Lamp and Appliance Circuits (EGT 2)

- Plan and install full apartment circuits
- Identify and fix real-world installation errors
- Includes:
 - o Client interaction and cost analysis
 - o Material lists and installation management
 - o First inspection per DIN VDE 0100-600
 - o Documentation and client training

Would you like help generating a Visual Basic module that automates logigram tracking and credential export based on InsTrain course completion and fault resolution?

▣ Visual Basic Code D - Fault Simulation and Credential Tracking

```
vb
' Module: InsTrainAuditManager
' Purpose: Automate fault simulation tracking and generate credential-linked
audit reports

Option Explicit

' Define learner structure
Type Learner
    ID As String
    Name As String
    CourseCode As String
    FaultsResolved As Integer
    TotalFaults As Integer
    CertificationStatus As String
End Type

Dim trainee As Learner

' Initialize learner data
Sub InitializeLearner(ID As String, Name As String, CourseCode As String)
    trainee.ID = ID
    trainee.Name = Name
    trainee.CourseCode = CourseCode
    trainee.FaultsResolved = 0
    trainee.TotalFaults = 10 ' Default number of fault simulations
    trainee.CertificationStatus = "Pending"
End Sub

' Simulate fault resolution
Sub ResolveFault(FaultID As Integer)
    If FaultID <= trainee.TotalFaults Then
        trainee.FaultsResolved = trainee.FaultsResolved + 1
        Debug.Print "Fault " & FaultID & " resolved by " & trainee.Name
    Else
        Debug.Print "Invalid Fault ID"
    End If
End Sub

' Evaluate certification status
Sub EvaluateCertification()
    If trainee.FaultsResolved >= trainee.TotalFaults * 0.8 Then
        trainee.CertificationStatus = "Certified"
    Else
        trainee.CertificationStatus = "Incomplete"
    End If
End Sub
```

```

        Debug.Print "Certification Status: " & trainee.CertificationStatus
End Sub

' Generate audit report
Sub GenerateAuditReport()
    Dim report As String
    report = "Audit Report for " & trainee.Name & vbCrLf
    report = report & "Course: " & trainee.CourseCode & vbCrLf
    report = report & "Faults Resolved: " & trainee.FaultsResolved & "/" &
trainee.TotalFaults & vbCrLf
    report = report & "Status: " & trainee.CertificationStatus & vbCrLf
    MsgBox report, vbInformation, "InsTrain Credential Report"
End Sub

```

□ How This Module Works

- Initializes learner profile and course context
- Tracks fault resolution progress
- Evaluates certification based on completion threshold (e.g., 80%)
- Generates a credential-linked audit report for export or LMS integration

:

□ Visual Basic Code - UniTrain-I Credential Tracker

```

vb
' Module: UniTrainICredentialTracker
' Purpose: Automate training progress, fault simulation, and credential-
linked reporting for UniTrain-I modules

Option Explicit

' Define structure for a learner profile
Type LearnerProfile
    ID As String
    Name As String
    ModuleCode As String
    DCCompleted As Boolean
    ACCompleted As Boolean
    ThreePhaseCompleted As Boolean
    FaultsResolved As Integer
    TotalFaults As Integer
    CertificationStatus As String
End Type

Dim trainee As LearnerProfile

' Initialize learner profile
Sub InitializeLearner(ID As String, Name As String, ModuleCode As String)
    With trainee
        .ID = ID
    End With
End Sub

```



```

        .Name = Name
        .ModuleCode = ModuleCode
        .DCCompleted = False
        .ACCompleted = False
        .ThreePhaseCompleted = False
        .FaultsResolved = 0
        .TotalFaults = 15
        .CertificationStatus = "Pending"
    End With
End Sub

' Mark module completion
Sub CompleteModule(ModuleName As String)
    Select Case ModuleName
        Case "DC"
            trainee.DCCompleted = True
        Case "AC"
            trainee.ACCompleted = True
        Case "ThreePhase"
            trainee.ThreePhaseCompleted = True
        Case Else
            MsgBox "Invalid module name"
    End Select
End Sub

' Simulate fault resolution
Sub ResolveFault(FaultID As Integer)
    If FaultID <= trainee.TotalFaults Then
        trainee.FaultsResolved = trainee.FaultsResolved + 1
        Debug.Print "Fault " & FaultID & " resolved by " & trainee.Name
    Else
        Debug.Print "Invalid Fault ID"
    End If
End Sub

' Evaluate certification status
Sub EvaluateCertification()
    If trainee.DCCompleted And trainee.ACCompleted And
trainee.ThreePhaseCompleted Then
        If trainee.FaultsResolved >= trainee.TotalFaults * 0.8 Then
            trainee.CertificationStatus = "Certified"
        Else
            trainee.CertificationStatus = "Incomplete – Faults"
        End If
    Else
        trainee.CertificationStatus = "Incomplete – Modules"
    End If
    Debug.Print "Certification Status: " & trainee.CertificationStatus
End Sub

' Generate audit report
Sub GenerateAuditReport()
    Dim report As String
    report = "UniTrain-I Audit Report" & vbCrLf

```

```

        report = report & "Learner: " & trainee.Name & " (" & trainee.ID & ")" &
vbCrLf
        report = report & "Module Code: " & trainee.ModuleCode & vbCrLf
        report = report & "DC Module: " & StatusText(trainee.DCCompleted) &
vbCrLf
        report = report & "AC Module: " & StatusText(trainee.ACCompleted) &
vbCrLf
        report = report & "Three-Phase Module: " &
StatusText(trainee.ThreePhaseCompleted) & vbCrLf
        report = report & "Faults Resolved: " & trainee.FaultsResolved & "/" &
trainee.TotalFaults & vbCrLf
        report = report & "Certification Status: " & trainee.CertificationStatus
& vbCrLf
        MsgBox report, vbInformation, "Credential Summary"
End Sub

' Helper function to convert Boolean to status text
Function StatusText(flag As Boolean) As String
    If flag Then
        StatusText = "Completed"
    Else
        StatusText = "Incomplete"
    End If
End Function

```

□ What This Code Supports

- Tracks completion of DC, AC, and Three-Phase modules
- Simulates fault resolution and validates minimum threshold
- Evaluates certification readiness based on module and fault criteria
- Generates a structured audit report for institutional or LMS export

Would you like to extend this module to include multilingual export or integrate logigram visualization for installation diagnostics?

□ Visual Basic Code - Research & Patent Traceability Module

```

vb
' Module: ResearchPatentManager
' Purpose: Automate research documentation, patent traceability, and scene
investigation using logigram logic

Option Explicit

' Define structure for a research project
Type ResearchProject
    ProjectID As String
    Title As String
    Investigator As String
    ScopeDefined As Boolean
    MethodologySet As Boolean
    DataAnalyzed As Boolean

```

```

        SceneInvestigated As Boolean
        PatentEligible As Boolean
        PatentFiled As Boolean
        CertificationStatus As String
End Type

Dim project As ResearchProject

' Initialize research project
Sub InitializeProject(ProjectID As String, Title As String, Investigator As String)
    With project
        .ProjectID = ProjectID
        .Title = Title
        .Investigator = Investigator
        .ScopeDefined = False
        .MethodologySet = False
        .DataAnalyzed = False
        .SceneInvestigated = False
        .PatentEligible = False
        .PatentFiled = False
        .CertificationStatus = "Pending"
    End With
End Sub

' Define scope and methodology
Sub DefineScopeAndMethodology()
    project.ScopeDefined = True
    project.MethodologySet = True
    Debug.Print "Scope and methodology defined for project: " & project.Title
End Sub

' Analyze data and investigate scene
Sub AnalyzeDataAndInvestigateScene()
    project.DataAnalyzed = True
    project.SceneInvestigated = True
    Debug.Print "Data analyzed and scene investigated for project: " & project.Title
End Sub

' Evaluate patent eligibility
Sub EvaluatePatentEligibility(Novelty As Boolean, Utility As Boolean, InventiveStep As Boolean)
    If Novelty And Utility And InventiveStep Then
        project.PatentEligible = True
        Debug.Print "Patent eligibility confirmed for project: " & project.Title
    Else
        project.PatentEligible = False
        Debug.Print "Patent eligibility not met for project: " & project.Title
    End If
End Sub

' File patent if eligible

```

```

Sub FilePatent()
    If project.PatentEligible Then
        project.PatentFiled = True
        Debug.Print "Patent filed for project: " & project.Title
    Else
        Debug.Print "Cannot file patent – eligibility not met."
    End If
End Sub

' Final certification evaluation
Sub EvaluateCertification()
    If project.ScopeDefined And project.MethodologySet And
project.DataAnalyzed And project.SceneInvestigated Then
        If project.PatentFiled Then
            project.CertificationStatus = "Certified – Patent Filed"
        Else
            project.CertificationStatus = "Certified – No Patent"
        End If
    Else
        project.CertificationStatus = "Incomplete"
    End If
    MsgBox "Certification Status: " & project.CertificationStatus,
vbInformation, "Research Audit Summary"
End Sub

```

□ What This Module Supports

- Tracks research lifecycle: scope, methodology, data analysis, scene investigation
- Evaluates patent eligibility based on novelty, utility, and inventive step
- Automates certification status and audit reporting
- Can be extended to export logigram diagrams or integrate with LMS platforms

Would you like to add multilingual export or integrate this with a Visual Basic-driven dashboard for institutional reporting?

:

□ Visual Basic Code - Research & Patent Framework Automation

```

vb
' Module: ResearchPatentFramework
' Purpose: Automate research documentation, patent traceability, and
credential-linked reporting

Option Explicit

' Define structure for a research and patent project

```

```

Type ResearchPatentProject
    ProjectID As String
    Title As String
    Investigator As String
    ScopeDefined As Boolean
    MethodologySet As Boolean
    DataDelivered As Boolean
    EthicsApproved As Boolean
    SceneInvestigated As Boolean
    LogigramCompleted As Boolean
    AlgorigramCompleted As Boolean
    PatentNovelty As Boolean
    PatentUtility As Boolean
    PatentInventiveStep As Boolean
    PatentFiled As Boolean
    CertificationStatus As String
End Type

Dim project As ResearchPatentProject

' Initialize project
Sub InitializeProject(ProjectID As String, Title As String, Investigator As String)
    With project
        .ProjectID = ProjectID
        .Title = Title
        .Investigator = Investigator
        .ScopeDefined = False
        .MethodologySet = False
        .DataDelivered = False
        .EthicsApproved = False
        .SceneInvestigated = False
        .LogigramCompleted = False
        .AlgorigramCompleted = False
        .PatentNovelty = False
        .PatentUtility = False
        .PatentInventiveStep = False
        .PatentFiled = False
        .CertificationStatus = "Pending"
    End With
End Sub

' Define scope and methodology
Sub DefineScopeAndMethodology()
    project.ScopeDefined = True
    project.MethodologySet = True
    Debug.Print "Scope and methodology defined for: " & project.Title
End Sub

' Deliver data and approve ethics
Sub DeliverDataAndApproveEthics()
    project.DataDelivered = True
    project.EthicsApproved = True
    Debug.Print "Data delivered and ethics approved for: " & project.Title
End Sub

```

```

' Investigate scene and complete diagrams
Sub InvestigateSceneAndDiagrams()
    project.SceneInvestigated = True
    project.LogigramCompleted = True
    project.AlgorigramCompleted = True
    Debug.Print "Scene investigation and diagrams completed for: " &
project.Title
End Sub

' Evaluate patent eligibility
Sub EvaluatePatent(Novelty As Boolean, Utility As Boolean, InventiveStep As
Boolean)
    project.PatentNovelty = Novelty
    project.PatentUtility = Utility
    project.PatentInventiveStep = InventiveStep
    If Novelty And Utility And InventiveStep Then
        project.PatentFiled = True
        Debug.Print "Patent filed for: " & project.Title
    Else
        Debug.Print "Patent eligibility not met for: " & project.Title
    End If
End Sub

' Final certification evaluation
Sub EvaluateCertification()
    If project.ScopeDefined And project.MethodologySet And
project.DataDelivered And project.EthicsApproved And
project.SceneInvestigated Then
        If project.PatentFiled Then
            project.CertificationStatus = "Certified – Patent Filed"
        Else
            project.CertificationStatus = "Certified – No Patent"
        End If
    Else
        project.CertificationStatus = "Incomplete"
    End If
    MsgBox "Certification Status: " & project.CertificationStatus,
vbInformation, "Research & Patent Summary"
End Sub

```

□ What This Module Supports

- Tracks research lifecycle: scope, methodology, ethics, data delivery
- Simulates scene investigation and diagram completion (logigram/alorigram)
- Evaluates patent eligibility under French law (L.611-11, L.611-14)
- Automates certification status and audit reporting

Would you like to extend this module to include multilingual export, dashboard integration, or dynamic logigram visualization?

▣ Visual Basic Code - Credentialing & Patent Recommendation Tracker

```
vb
' Module: CredentialPatentManager
' Purpose: Automate teaching certification and patent recommendation workflow
using logigram and algorigram logic

Option Explicit

' Define structure for applicant profile
Type ApplicantProfile
    ApplicantID As String
    FullName As String
    CredentialType As String
    CreditsCompleted As Integer
    EducationCredits As Integer
    ExperienceHours As Long
    PatentNovelty As Boolean
    PatentUtility As Boolean
    PatentInventiveStep As Boolean
    PatentEligible As Boolean
    CertificationReady As Boolean
End Type

Dim applicant As ApplicantProfile

' Initialize applicant profile
Sub InitializeApplicant(ID As String, Name As String, CredentialType As
String)
    With applicant
        .ApplicantID = ID
        .FullName = Name
        .CredentialType = CredentialType
        .CreditsCompleted = 0
        .EducationCredits = 0
        .ExperienceHours = 0
        .PatentNovelty = False
        .PatentUtility = False
        .PatentInventiveStep = False
        .PatentEligible = False
        .CertificationReady = False
    End With
End Sub

' Validate teaching credential eligibility
Sub ValidateTeachingCredential()
    If applicant.CredentialType = "Provisional" Then
        If applicant.CreditsCompleted >= 90 And applicant.EducationCredits >=
45 Then
            applicant.CertificationReady = True
        Else
```

```

        applicant.CertificationReady = False
    End If
ElseIf applicant.CredentialType = "General" Then
    If applicant.ExperienceHours >= 3000 Then
        applicant.CertificationReady = True
    Else
        applicant.CertificationReady = False
    End If
End If
End Sub

' Evaluate patent eligibility
Sub EvaluatePatentEligibility(Novelty As Boolean, Utility As Boolean,
InventiveStep As Boolean)
    applicant.PatentNovelty = Novelty
    applicant.PatentUtility = Utility
    applicant.PatentInventiveStep = InventiveStep
    If Novelty And Utility And InventiveStep Then
        applicant.PatentEligible = True
    Else
        applicant.PatentEligible = False
    End If
End Sub

' Generate audit report
Sub GenerateAuditReport()
    Dim report As String
    report = "Audit Summary for " & applicant.FullName & vbCrLf
    report = report & "Applicant ID: " & applicant.ApplicantID & vbCrLf
    report = report & "Credential Type: " & applicant.CredentialType & vbCrLf
    report = report & "Credits Completed: " & applicant.CreditsCompleted &
" / Education Credits: " & applicant.EducationCredits & vbCrLf
    report = report & "Experience Hours: " & applicant.ExperienceHours &
vbCrLf
    report = report & "Teaching Certification Ready: " &
StatusText(applicant.CertificationReady) & vbCrLf
    report = report & "Patent Eligibility: " &
StatusText(applicant.PatentEligible) & vbCrLf
    MsgBox report, vbInformation, "Credential & Patent Recommendation"
End Sub

' Helper function to convert Boolean to status text
Function StatusText(flag As Boolean) As String
    If flag Then
        StatusText = "Yes"
    Else
        StatusText = "No"
    End If
End Function

```

□ What This Module Supports

- Tracks applicant progress for teaching certification (provisional or general)

- Validates patent eligibility based on novelty, utility, and inventive step
- Automates logigram-style decision logic and algorigram-style procedural flow
- Generates audit-ready summaries for institutional or legal submission

□ Visual Basic Code - InsTrain Multi-Domain Tracker

```

vb
' Module: InsTrainBuildingTechManager
' Purpose: Track learner progress across InsTrain modules, simulate fault
resolution, and generate audit reports

Option Explicit

' Define structure for a learner's training profile
Type LearnerTraining
    LearnerID As String
    Name As String
    MultimediaCabling As Boolean
    KNXBuildingControl As Boolean
    DangerDetection As Boolean
    DomesticPowerSupply As Boolean
    FaultsResolved As Integer
    TotalFaults As Integer
    CertificationStatus As String
End Type

Dim trainee As LearnerTraining

' Initialize learner profile
Sub InitializeLearner(ID As String, Name As String)
    With trainee
        .LearnerID = ID
        .Name = Name
        .MultimediaCabling = False
        .KNXBuildingControl = False
        .DangerDetection = False
        .DomesticPowerSupply = False
        .FaultsResolved = 0
        .TotalFaults = 20
        .CertificationStatus = "Pending"
    End With
End Sub

' Mark module completion
Sub CompleteModule(ModuleName As String)
    Select Case ModuleName
        Case "Multimedia"
            trainee.MultimediaCabling = True
        Case "KNX"
            trainee.KNXBuildingControl = True
        Case "DangerDetection"
            trainee.DangerDetection = True
    End Select
End Sub

```

```

        Case "DomesticPower"
            trainee.DomesticPowerSupply = True
        Case Else
            MsgBox "Invalid module name"
        End Select
    End Sub

' Simulate fault resolution
Sub ResolveFault(FaultID As Integer)
    If FaultID <= trainee.TotalFaults Then
        trainee.FaultsResolved = trainee.FaultsResolved + 1
        Debug.Print "Fault " & FaultID & " resolved by " & trainee.Name
    Else
        Debug.Print "Invalid Fault ID"
    End If
End Sub

' Evaluate certification status
Sub EvaluateCertification()
    If trainee.MultimediaCabling And trainee.KNXBuildingControl And
trainee.DangerDetection And trainee.DomesticPowerSupply Then
        If trainee.FaultsResolved >= trainee.TotalFaults * 0.75 Then
            trainee.CertificationStatus = "Certified – All Modules Completed"
        Else
            trainee.CertificationStatus = "Incomplete – Faults"
        End If
    Else
        trainee.CertificationStatus = "Incomplete – Modules"
    End If
    MsgBox "Certification Status: " & trainee.CertificationStatus,
vbInformation, "InsTrain Audit Summary"
End Sub

' Generate audit report
Sub GenerateAuditReport()
    Dim report As String
    report = "InsTrain Audit Report for " & trainee.Name & vbCrLf
    report = report & "Learner ID: " & trainee.LearnerID & vbCrLf
    report = report & "Multimedia Cabling: " &
StatusText(trainee.MultimediaCabling) & vbCrLf
    report = report & "KNX Building Control: " &
StatusText(trainee.KNXBuildingControl) & vbCrLf
    report = report & "Danger Detection & Access Control: " &
StatusText(trainee.DangerDetection) & vbCrLf
    report = report & "Domestic Power Supply: " &
StatusText(trainee.DomesticPowerSupply) & vbCrLf
    report = report & "Faults Resolved: " & trainee.FaultsResolved & "/" &
trainee.TotalFaults & vbCrLf
    report = report & "Certification Status: " & trainee.CertificationStatus
& vbCrLf
    MsgBox report, vbInformation, "Final Credential Summary"
End Sub

' Helper function to convert Boolean to status text
Function StatusText(flag As Boolean) As String

```

```

If flag Then
    StatusText = "Completed"
Else
    StatusText = "Incomplete"
End If
End Function

```

□ What This Module Supports

- Tracks learner progress across four InsTrain modules:
 - Multimedia Cabling
 - KNX Building Control
 - Danger Detection & Access Control
 - Domestic Power Supply
- Simulates fault resolution with a customizable threshold
- Automates certification evaluation and generates audit-ready summaries

Would you like to extend this module to include multilingual export or integrate it with LabSoft

:

□ Research and Technical Framework (English Translation)

1. Overview, Scope, and Description

- **Overview:** This research explores structured building technology training using InsTrain systems developed by Lucas-Nülle.
- **Scope:** Covers multimedia cabling, KNX® building automation, danger detection and access control, and domestic power distribution.
- **Description:** Each module combines theoretical planning, hands-on installation, and fault simulation to prepare learners for modern building infrastructure roles.

2. Statement and Research Methodology

- **Statement:** The study evaluates how modular, simulator-enhanced training improves learner autonomy, diagnostic precision, and compliance with technical standards.
- **Methodology:**
 - Project-based learning
 - Guided fault simulation
 - Interactive theory modules

- o Standards-based evaluation (DIN/VDE, KNX®, VdS)

3. Information Management System

- **Delivery:**
 - o LabSoft software with course navigator
 - o CD-ROMs, planning tools, and virtual instruments
- **Investigation Principles:**
 - o Ethical and procedural compliance
 - o Real-time feedback and learner adaptation
- **Data Analysis:**
 - o Measurement via 3-channel interfaces
 - o Protocol generation and client training reports

4. Collision Incidence Scene Research Method

- **Scene Investigation:**
 - o Fault tracing in multimedia cabling, KNX® systems, and danger detection setups
 - o Use of error simulators and programmable modules
- **Tools:**
 - o Visual Basic-coded logigrams and algorigram logic
 - o Sensor data, time-sequence mapping, and diagnostic protocols

5. Logigram and Algorigram in Visual Basic

- **Logigram:** Flowchart diagrams for installation planning, fault tracing, and system commissioning.
- **Algorigram:** Procedural logic coded in Visual Basic to automate diagnostics, course tracking, and credential export.
- **Visual Basic Code:** Supports modular audit sheets, error simulation, and standards-based evaluation.

6. Conclusion and Bibliographic References

- **Conclusion:**
 - o InsTrain modules offer scalable, standards-aligned training for future-ready building technicians.
 - o Learners gain hands-on experience in planning, installation, and diagnostics across multiple domains.
- **Bibliography:**
 - o Lucas-Nülle manuals
 - o DIN/VDE standards
 - o KNX® ETS3 documentation
 - o VdS certification guidelines

□ InsTrain Module Highlights

Module	Key Learning Areas
Multimedia Cabling (EGT 3)	Wi-Fi setup, RJ45 wiring, patch panels, DVB-T signal routing, ADSL commissioning
KNX® Building Automation (EGT 4)	Bus topology, ETS3 programming, energy optimization, centralized lighting and shading
Danger Detection & Access Control (EGT 5)	Fire/gas/water sensors, alarm systems, bus-based detectors, VdS-certified modules
Domestic Power Supply (EGI 1)	Main distribution planning, DIN/VDE compliance, lightning protection, manual installation

Would you like help generating a Visual Basic module that automates logigram tracking and

□ Research and Technical Framework (English Translation)

1. Overview, Scope, and Description

- **Overview:** This framework explores modular training systems for electrical installation, communication, and protection technologies using InsTrain and Lucas-Nülle experimental platforms.
- **Scope:** Covers multimedia cabling, apartment installations, KNX® building automation, danger detection, and protection systems aligned with VDE/EN standards.
- **Description:** Combines hands-on training, fault simulation, and standards-based evaluation to prepare learners for real-world electrical and building infrastructure roles.

2. Statement and Research Methodology

- **Statement:** The research investigates how modular, simulator-enhanced training improves technical competence, safety awareness, and standards compliance.
- **Methodology:**
 - Project-based learning
 - Fault simulation and guided troubleshooting
 - Measurement and documentation protocols
 - Evaluation aligned with DIN VDE 0100 standards

3. Information Management System

- **Delivery:**
 - LabSoft software with course navigator
 - CD-ROMs, planning tools, and virtual instruments
- **Investigation Principles:**
 - Ethical and procedural compliance
 - Real-time feedback and learner adaptation
- **Data Analysis:**
 - Loop impedance, insulation resistance, fault tracing
 - Protocol generation and client training reports

4. Collision Incidence Scene Research Method

- **Scene Investigation:**
 - Fault tracing in multimedia cabling, KNX® systems, and danger detection setups
 - Use of error simulators and programmable modules
- **Tools:**
 - Visual Basic-coded logigrams and algorigram logic
 - Sensor data, time-sequence mapping, and diagnostic protocols

5. Logigram and Algorigram in Visual Basic

- **Logigram:** Flowchart diagrams for installation planning, fault tracing, and system commissioning.
- **Algorigram:** Procedural logic coded in Visual Basic to automate diagnostics, course tracking, and credential export.
- **Visual Basic Code:** Supports modular audit sheets, error simulation, and standards-based evaluation.

6. Conclusion and Bibliographic References

- **Conclusion:**
 - InsTrain and experimental plate systems offer scalable, standards-aligned training for future-ready building technicians.
 - Learners gain hands-on experience in planning, installation, diagnostics, and safety compliance.
- **Bibliography:**
 - Lucas-Nülle manuals
 - DIN/VDE standards
 - KNX® ETS3 documentation
 - VdS certification guidelines

□ Didactic Content Summary

□ Multimedia Cabling

- Planning structured cabling
- Wi-Fi setup, RJ45 wiring, patch panels
- ADSL commissioning and DVB-T signal routing

□ **Apartment Installation**

- Client order execution
- Room configuration and component wiring
- DIN/VDE-compliant testing and documentation

□ **KNX® Building Automation**

- ETS3 programming, bus topology, energy optimization
- Centralized lighting, shading, and temperature control

□ **Danger Detection & Access Control**

- Fire, gas, water, and intrusion sensors
- Alarm systems and bus-based detectors
- VdS-certified modules and programmable logic

□ **Experimental Plate Systems**

- Modular A4-format panels for flexible training
- VDE/EN protection measures, fault simulation
- Realistic industrial components and safety sockets

⚡ **Protection Systems**

- TT, TN, TN-C, TN-S, TN-C-S neutral regimes
- RCD/DDR testing, loop impedance, insulation resistance
- Fault evaluation and safety documentation

□ **IT Systems (Specialized Neutral Regime)**

- Used in mining, military, and hospital power systems
- Includes isolation transformer and insulation monitor

Would you like help generating a Visual Basic module that automates logigram tracking and credential export across these modules, including fault simulation and standards compliance?

□ **Visual Basic Code - Modular Training & Evaluation Framework**

```

vb
' Module: ModularTrainingEvaluator
' Purpose: Automate learner progress, fault simulation, and standards-based
evaluation across InsTrain and experimental plate systems

Option Explicit

' Define structure for learner profile
Type LearnerProfile
    LearnerID As String
    Name As String
    MultimediaCabling As Boolean
    ApartmentInstallation As Boolean
    KNXAutomation As Boolean
    DangerDetection As Boolean
    ExperimentalPlates As Boolean
    ProtectionSystems As Boolean
    ITSystems As Boolean
    FaultsResolved As Integer
    TotalFaults As Integer
    CertificationStatus As String
End Type

Dim trainee As LearnerProfile

' Initialize learner profile
Sub InitializeLearner(ID As String, Name As String)
    With trainee
        .LearnerID = ID
        .Name = Name
        .MultimediaCabling = False
        .ApartmentInstallation = False
        .KNXAutomation = False
        .DangerDetection = False
        .ExperimentalPlates = False
        .ProtectionSystems = False
        .ITSystems = False
        .FaultsResolved = 0
        .TotalFaults = 30
        .CertificationStatus = "Pending"
    End With
End Sub

' Mark module completion
Sub CompleteModule(ModuleName As String)
    Select Case ModuleName
        Case "Multimedia"
            trainee.MultimediaCabling = True
        Case "Apartment"
            trainee.ApartmentInstallation = True
        Case "KNX"
            trainee.KNXAutomation = True
        Case "Danger"
            trainee.DangerDetection = True
        Case "Plates"

```



```

        trainee.ExperimentalPlates = True
    Case "Protection"
        trainee.ProtectionSystems = True
    Case "IT"
        trainee.ITSystems = True
    Case Else
        MsgBox "Invalid module name"
    End Select
End Sub

' Simulate fault resolution
Sub ResolveFault(FaultID As Integer)
    If FaultID <= trainee.TotalFaults Then
        trainee.FaultsResolved = trainee.FaultsResolved + 1
        Debug.Print "Fault " & FaultID & " resolved by " & trainee.Name
    Else
        Debug.Print "Invalid Fault ID"
    End If
End Sub

' Evaluate certification status
Sub EvaluateCertification()
    If trainee.MultimediaCabling And trainee.ApartmentInstallation And
trainee.KNXAutomation And _
        trainee.DangerDetection And trainee.ExperimentalPlates And
trainee.ProtectionSystems And trainee.ITSystems Then
        If trainee.FaultsResolved >= trainee.TotalFaults * 0.8 Then
            trainee.CertificationStatus = "Certified – All Modules Completed"
        Else
            trainee.CertificationStatus = "Incomplete – Faults"
        End If
    Else
        trainee.CertificationStatus = "Incomplete – Modules"
    End If
    MsgBox "Certification Status: " & trainee.CertificationStatus,
vbInformation, "Modular Training Audit Summary"
End Sub

' Generate audit report
Sub GenerateAuditReport()
    Dim report As String
    report = "Audit Report for " & trainee.Name & vbCrLf
    report = report & "Learner ID: " & trainee.LearnerID & vbCrLf
    report = report & "Multimedia Cabling: " &
StatusText(trainee.MultimediaCabling) & vbCrLf
    report = report & "Apartment Installation: " &
StatusText(trainee.ApartmentInstallation) & vbCrLf
    report = report & "KNX Automation: " & StatusText(trainee.KNXAutomation)
& vbCrLf
    report = report & "Danger Detection: " &
StatusText(trainee.DangerDetection) & vbCrLf
    report = report & "Experimental Plates: " &
StatusText(trainee.ExperimentalPlates) & vbCrLf
    report = report & "Protection Systems: " &
StatusText(trainee.ProtectionSystems) & vbCrLf

```

```

        report = report & "IT Systems: " & StatusText(trainee.ITSystems) & vbCrLf
        report = report & "Faults Resolved: " & trainee.FaultsResolved & "/" &
trainee.TotalFaults & vbCrLf
        report = report & "Certification Status: " & trainee.CertificationStatus
& vbCrLf
        MsgBox report, vbInformation, "Final Credential Summary"
End Sub

' Helper function to convert Boolean to status text
Function StatusText(flag As Boolean) As String
    If flag Then
        StatusText = "Completed"
    Else
        StatusText = "Incomplete"
    End If
End Function

```

□ What This Module Supports

- Tracks learner progress across 7 modular domains
- Simulates fault resolution with customizable thresholds
- Automates standards-based certification evaluation
- Generates audit-ready summaries for institutional or LMS export

□ Visual Basic Code - Advanced Building Systems Evaluator

```

vb
' Module: AdvancedBuildingSystemsEvaluator
' Purpose: Track learner progress across Lucas-Nülle modules and automate
fault simulation and certification evaluation

Option Explicit

' Define structure for learner profile
Type LearnerProfile
    LearnerID As String
    Name As String
    LightningProtection As Boolean
    RCDSystems As Boolean
    DeviceTesting As Boolean
    NetworkQuality As Boolean
    LightingCircuits As Boolean
    IntercomSystems As Boolean
    KNXAutomation As Boolean
    Surveillance As Boolean
    HeatingControl As Boolean
    WeatherStation As Boolean
    FaultsResolved As Integer
    TotalFaults As Integer
    CertificationStatus As String
End Type

Dim trainee As LearnerProfile

```

```

' Initialize learner profile
Sub InitializeLearner(ID As String, Name As String)
    With trainee
        .LearnerID = ID
        .Name = Name
        .LightningProtection = False
        .RCDSystems = False
        .DeviceTesting = False
        .NetworkQuality = False
        .LightingCircuits = False
        .IntercomSystems = False
        .KNXAutomation = False
        .Surveillance = False
        .HeatingControl = False
        .WeatherStation = False
        .FaultsResolved = 0
        .TotalFaults = 40
        .CertificationStatus = "Pending"
    End With
End Sub

' Mark module completion
Sub CompleteModule(ModuleName As String)
    Select Case ModuleName
        Case "Lightning"
            trainee.LightningProtection = True
        Case "RCD"
            trainee.RCDSystems = True
        Case "DeviceTesting"
            trainee.DeviceTesting = True
        Case "NetworkQuality"
            trainee.NetworkQuality = True
        Case "Lighting"
            trainee.LightingCircuits = True
        Case "Intercom"
            trainee.IntercomSystems = True
        Case "KNX"
            trainee.KNXAutomation = True
        Case "Surveillance"
            trainee.Surveillance = True
        Case "Heating"
            trainee.HeatingControl = True
        Case "Weather"
            trainee.WeatherStation = True
        Case Else
            MsgBox "Invalid module name"
    End Select
End Sub

' Simulate fault resolution
Sub ResolveFault(FaultID As Integer)
    If FaultID <= trainee.TotalFaults Then
        trainee.FaultsResolved = trainee.FaultsResolved + 1
        Debug.Print "Fault " & FaultID & " resolved by " & trainee.Name
    End If
End Sub

```

```

Else
    Debug.Print "Invalid Fault ID"
End If
End Sub

' Evaluate certification status
Sub EvaluateCertification()
    If trainee.LightningProtection And trainee.RCDSystems And
trainee.DeviceTesting And trainee.NetworkQuality And _
trainee.LightingCircuits And trainee.IntercomSystems And
trainee.KNXAutomation And trainee.Surveillance And _
trainee.HeatingControl And trainee.WeatherStation Then
        If trainee.FaultsResolved >= trainee.TotalFaults * 0.75 Then
            trainee.CertificationStatus = "Certified – All Modules Completed"
        Else
            trainee.CertificationStatus = "Incomplete – Faults"
        End If
    Else
        trainee.CertificationStatus = "Incomplete – Modules"
    End If
    MsgBox "Certification Status: " & trainee.CertificationStatus,
vbInformation, "Advanced Systems Audit Summary"
End Sub

' Generate audit report
Sub GenerateAuditReport()
    Dim report As String
    report = "Audit Report for " & trainee.Name & vbCrLf
    report = report & "Learner ID: " & trainee.LearnerID & vbCrLf
    report = report & "Lightning Protection: " &
StatusText(trainee.LightningProtection) & vbCrLf
    report = report & "RCD Systems: " & StatusText(trainee.RCDSystems) &
vbCrLf
    report = report & "Device Testing: " & StatusText(trainee.DeviceTesting)
& vbCrLf
    report = report & "Network Quality: " &
StatusText(trainee.NetworkQuality) & vbCrLf
    report = report & "Lighting Circuits: " &
StatusText(trainee.LightingCircuits) & vbCrLf
    report = report & "Intercom Systems: " &
StatusText(trainee.IntercomSystems) & vbCrLf
    report = report & "KNX Automation: " & StatusText(trainee.KNXAutomation)
& vbCrLf
    report = report & "Surveillance: " & StatusText(trainee.Surveillance) &
vbCrLf
    report = report & "Heating Control: " &
StatusText(trainee.HeatingControl) & vbCrLf
    report = report & "Weather Station: " &
StatusText(trainee.WeatherStation) & vbCrLf
    report = report & "Faults Resolved: " & trainee.FaultsResolved & "/" &
trainee.TotalFaults & vbCrLf
    report = report & "Certification Status: " & trainee.CertificationStatus
& vbCrLf
    MsgBox report, vbInformation, "Final Credential Summary"
End Sub

```

```
' Helper function to convert Boolean to status text
Function StatusText(flag As Boolean) As String
    If flag Then
        StatusText = "Completed"
    Else
        StatusText = "Incomplete"
    End If
End Function
```



□ Research and Technical Framework (English Translation)

1. Overview, Scope, and Description

- **Overview:** This framework explores modular training systems for electrical protection, diagnostics, and building automation using Lucas-Nülle experimental platforms.
- **Scope:** Covers lightning protection, residual current devices (RCD/DDR), electrical device testing, network quality analysis, conventional lighting circuits, domestic signaling systems, and KNX®/EIB bus automation.
- **Description:** Combines hands-on experimentation, fault simulation, and standards-based evaluation to prepare learners for real-world electrical infrastructure and safety compliance.

2. Statement and Research Methodology

- **Statement:** The research investigates how modular, simulator-enhanced training improves technical competence, fault detection, and compliance with VDE/EN standards.
- **Methodology:**
 - Project-based learning
 - Fault simulation and guided troubleshooting
 - Measurement and documentation protocols
 - Evaluation aligned with DIN VDE 0100, VDE 0701-0702, and BDV A3 standards

3. Information Management System

- **Delivery:**
 - LabSoft software with course navigator
 - CD-ROMs, planning tools, and virtual instruments
- **Investigation Principles:**

- o Ethical and procedural compliance
 - o Real-time feedback and learner adaptation
- **Data Analysis:**
 - o Fault current behavior, loop impedance, insulation resistance
 - o Trigger thresholds, waveform analysis, and protocol generation

4. Collision Incidence Scene Research Method

- **Scene Investigation:**
 - o Fault tracing in lightning protection networks, RCD systems, and KNX® installations
 - o Use of impulse generators, error simulators, and programmable modules
- **Tools:**
 - o Visual Basic-coded logigrams and algorigram logic
 - o Sensor data, time-sequence mapping, and diagnostic protocols

5. Logigram and Algorigram in Visual Basic

- **Logigram:** Flowchart-style diagrams for installation planning, fault tracing, and system commissioning.
- **Algorigram:** Algorithmic logic coded in Visual Basic to automate diagnostics, course tracking, and credential export.
- **Visual Basic Code:** Supports modular audit sheets, error simulation, and standards-based evaluation.

6. Conclusion and Bibliographic References

- **Conclusion:**
 - o Lucas-Nülle systems offer scalable, standards-aligned training for future-ready technicians.
 - o Learners gain hands-on experience in planning, installation, diagnostics, and safety compliance.
- **Bibliography:**
 - o Lucas-Nülle manuals
 - o DIN/VDE standards (0100, 0701-0702, 60364-4-41)
 - o BDV A3 guidelines
 - o KNX® ETS3 documentation

□ Didactic Content Summary

✂ Lightning Protection (ESM 4)

- Simulated lightning impulse (10/350 waveform)
- Surge coupling near/far from transformer

- Planning multi-level protection (B, C, D)
- Error analysis for improper protection layering

□ **RCD Systems (ESM 5)**

- TN/TT neutral regimes
- Type A and B RCDs
- Selectivity and fault current evaluation
- DIN VDE 0100-530, 0100-410, 0100-723 compliance

□ **Electrical Device Testing (ESM 6)**

- VDE 0701-0702 protocols
- Class I, II, III equipment
- Error simulation and systematic fault tracing
- BDV A3 evaluation standards

□ **Network Quality Analysis (ESM 7)**

- Harmonic distortion and asymmetry
- Non-linear lighting loads
- PEN conductor effects
- Overload risks and cable sizing

□ **Lighting Circuits (EIT 1)**

- Conventional switching schemes
- Fluorescent and halogen circuits
- Efficiency calculations and ballast behavior

□ **Domestic Signaling Systems (EIT 2)**

- Intercom and door release systems
- Multi-voltage configuration
- Combined signaling and communication setups

□ **KNX®/EIB Bus Automation (EIT 8.1)**

- Decentralized terminal programming
- Centralized and local control of lighting, blinds, heating
- Integration of conventional switches
- Surveillance and weather station extensions

Would you like help generating a Visual Basic module that automates logigram tracking and credential export across these modules, including fault simulation and standards compliance?

k:

□ Research and Technical Framework - Industrial Installation, Automation, and Renewable Energy

1. Overview, Scope, and Description

- **Overview:** This framework focuses on modular training systems for industrial electrical installation, programmable logic control (PLC), and renewable energy systems using Lucas-Nülle experimental platforms.
- **Scope:** Covers manual and contactor-based three-phase switching, programmable logic controllers (LOGO!®), bus system integration (KNX®, AS-Interface), conveyor and gate control, and photovoltaic (PV) systems.
- **Description:** Learners develop practical skills in circuit design, motor control, programmable automation, and energy systems through hands-on experimentation and standards-based evaluation.

2. Statement and Research Methodology

- **Statement:** The research investigates how modular, simulator-based training enhances learner competence in industrial automation, safety, and energy efficiency.
- **Methodology:**
 - Project-based learning
 - Functional diagram programming
 - Fault simulation and guided troubleshooting
 - Standards-aligned evaluation (DIN VDE, IEC)

3. Information Management System

- **Delivery:**
 - LabSoft software with multimedia self-learning modules
 - Functional diagrams and PC-based programming interfaces
- **Investigation Principles:**
 - Real-time feedback and error simulation
 - Integration of conventional and programmable control systems
- **Data Analysis:**

- o Motor behavior, switching logic, PV output, and fault response
- o Documentation of test results and commissioning protocols

4. Collision Incidence Scene Research Method

- **Scene Investigation:**
 - o Fault tracing in motor circuits, relay logic, and PV systems
 - o Simulation of overloads, switching errors, and shading effects
- **Tools:**
 - o Visual Basic-coded logigrams and algorigram logic
 - o Functional diagrams, time-sequence mapping, and programmable logic

5. Logigram and Algorigram in Visual Basic

- **Logigram:** Flowchart-style diagrams for motor control, switching sequences, and PV diagnostics.
- **Algorigram:** Procedural logic coded in Visual Basic to automate diagnostics, course tracking, and credential export.
- **Visual Basic Code:** Supports modular audit sheets, error simulation, and standards-based evaluation.

6. Conclusion and Bibliographic References

- **Conclusion:**
 - o Lucas-Nülle systems provide scalable, standards-aligned training for industrial electricians and automation technicians.
 - o Learners gain hands-on experience in planning, programming, diagnostics, and renewable energy integration.
- **Bibliography:**
 - o Lucas-Nülle manuals
 - o DIN VDE 0100, 0113, 0701-0702
 - o IEC 61131 (PLC programming)
 - o KNX® and AS-Interface documentation

□ Didactic Content Summary

□ Manual and Contactor-Based Three-Phase Switching (EST 1-2)

- Star-delta and pole-changing circuits
- Dahlander motor switching
- Self-holding contactor circuits
- Timed relays and mechanical limit switches
- Safety and protection functions

□ Programmable Logic Controllers - LOGO!® (EST 4, EST 6)

- Basic and advanced logic programming
- Functional diagram design
- LOGO!® Soft Comfort software
- Conveyor and gate control projects
- Integration with conventional relay logic

□ Bus System Interfaces (LOGO!® Extensions)

- LOGO!® DM8: I/O expansion
- LOGO!® CM EIB/KNX: KNX® bus integration
- LOGO!® CM AS: AS-Interface slave integration

✱ Renewable Energy - Photovoltaics (EPH 9542)

- Grid-tied and off-grid PV systems
- Energy measurement and shading analysis
- Optimal orientation and circuit types
- PV behavior during grid failure

□ Visual Basic Code - Industrial Installation & Renewable Energy Evaluator

vb

```
' Module: IndustrialEnergyTrainingManager
' Purpose: Track learner progress across industrial installation and
renewable energy modules, simulate fault resolution, and generate audit
reports
```

Option Explicit

```
' Define structure for learner profile
Type LearnerProfile
    LearnerID As String
    Name As String
    ManualThreePhaseSwitching As Boolean
    ContactorCircuits As Boolean
    ProgrammableLogicLOGO As Boolean
    ConveyorControl As Boolean
    SlidingGateControl As Boolean
    SolarPVSystems As Boolean
    WindTurbines As Boolean
    FuelCells As Boolean
    FaultsResolved As Integer
    TotalFaults As Integer
    CertificationStatus As String
End Type
```

```

Dim trainee As LearnerProfile

' Initialize learner profile
Sub InitializeLearner(ID As String, Name As String)
    With trainee
        .LearnerID = ID
        .Name = Name
        .ManualThreePhaseSwitching = False
        .ContactorCircuits = False
        .ProgrammableLogicLOGO = False
        .ConveyorControl = False
        .SlidingGateControl = False
        .SolarPVSystems = False
        .WindTurbines = False
        .FuelCells = False
        .FaultsResolved = 0
        .TotalFaults = 50
        .CertificationStatus = "Pending"
    End With
End Sub

' Mark module completion
Sub CompleteModule(ModuleName As String)
    Select Case ModuleName
        Case "ThreePhase"
            trainee.ManualThreePhaseSwitching = True
        Case "Contactors"
            trainee.ContactorCircuits = True
        Case "LOGO"
            trainee.ProgrammableLogicLOGO = True
        Case "Conveyor"
            trainee.ConveyorControl = True
        Case "Gate"
            trainee.SlidingGateControl = True
        Case "Solar"
            trainee.SolarPVSystems = True
        Case "Wind"
            trainee.WindTurbines = True
        Case "FuelCell"
            trainee.FuelCells = True
        Case Else
            MsgBox "Invalid module name"
    End Select
End Sub

' Simulate fault resolution
Sub ResolveFault(FaultID As Integer)
    If FaultID <= trainee.TotalFaults Then
        trainee.FaultsResolved = trainee.FaultsResolved + 1
        Debug.Print "Fault " & FaultID & " resolved by " & trainee.Name
    Else
        Debug.Print "Invalid Fault ID"
    End If
End Sub

```

```

' Evaluate certification status
Sub EvaluateCertification()
    If trainee.ManualThreePhaseSwitching And trainee.ContactorCircuits And
trainee.ProgrammableLogicLOGO And _
        trainee.ConveyorControl And trainee.SlidingGateControl And
trainee.SolarPVSystems And _
        trainee.WindTurbines And trainee.FuelCells Then
        If trainee.FaultsResolved >= trainee.TotalFaults * 0.75 Then
            trainee.CertificationStatus = "Certified – All Modules Completed"
        Else
            trainee.CertificationStatus = "Incomplete – Faults"
        End If
    Else
        trainee.CertificationStatus = "Incomplete – Modules"
    End If
    MsgBox "Certification Status: " & trainee.CertificationStatus,
vbInformation, "Industrial Training Audit Summary"
End Sub

```

```

' Generate audit report
Sub GenerateAuditReport()
    Dim report As String
    report = "Audit Report for " & trainee.Name & vbCrLf
    report = report & "Learner ID: " & trainee.LearnerID & vbCrLf
    report = report & "Manual Three-Phase Switching: " &
StatusText(trainee.ManualThreePhaseSwitching) & vbCrLf
    report = report & "Contactor Circuits: " &
StatusText(trainee.ContactorCircuits) & vbCrLf
    report = report & "Programmable Logic (LOGO!®): " &
StatusText(trainee.ProgrammableLogicLOGO) & vbCrLf
    report = report & "Conveyor Control: " &
StatusText(trainee.ConveyorControl) & vbCrLf
    report = report & "Sliding Gate Control: " &
StatusText(trainee.SlidingGateControl) & vbCrLf
    report = report & "Solar PV Systems: " &
StatusText(trainee.SolarPVSystems) & vbCrLf
    report = report & "Wind Turbines: " & StatusText(trainee.WindTurbines) &
vbCrLf
    report = report & "Fuel Cells: " & StatusText(trainee.FuelCells) & vbCrLf
    report = report & "Faults Resolved: " & trainee.FaultsResolved & "/" &
trainee.TotalFaults & vbCrLf
    report = report & "Certification Status: " & trainee.CertificationStatus
& vbCrLf
    MsgBox report, vbInformation, "Final Credential Summary"
End Sub

```

```

' Helper function to convert Boolean to status text
Function StatusText(flag As Boolean) As String
    If flag Then
        StatusText = "Completed"
    Else
        StatusText = "Incomplete"
    End If
End Function

```



ion, and audit-ready certification across these practical domains:

Visual Basic Code - Project-Based Electrical Installation Evaluator

```
vb
' Module: ProjectInstallationEvaluator
' Purpose: Track learner progress across practical installation modules,
simulate fault resolution, and generate audit reports
```

```
Option Explicit
```

```
' Define structure for learner profile
```

```
Type LearnerProfile
```

```
    LearnerID As String
```

```
    Name As String
```

```
    StaircaseLighting As Boolean
```

```
    DomesticSignaling As Boolean
```

```
    EnergyMeterCabinet As Boolean
```

```
    TelecomModernization As Boolean
```

```
    StarDeltaSwitching As Boolean
```

```
    ManualWiringSkills As Boolean
```

```
    CabinetAssembly As Boolean
```

```
    FaultsResolved As Integer
```

```
    TotalFaults As Integer
```

```
    CertificationStatus As String
```

```
End Type
```

```
Dim trainee As LearnerProfile
```

```
' Initialize learner profile
```

```
Sub InitializeLearner(ID As String, Name As String)
```

```
    With trainee
```

```
        .LearnerID = ID
```

```
        .Name = Name
```

```
        .StaircaseLighting = False
```

```
        .DomesticSignaling = False
```

```
        .EnergyMeterCabinet = False
```

```
        .TelecomModernization = False
```

```
        .StarDeltaSwitching = False
```

```
        .ManualWiringSkills = False
```

```
        .CabinetAssembly = False
```

```
        .FaultsResolved = 0
```

```
        .TotalFaults = 40
```

```
        .CertificationStatus = "Pending"
```

```
    End With
```

```
End Sub
```

```
' Mark module completion
```

```
Sub CompleteModule(ModuleName As String)
```

```
    Select Case ModuleName
```

```

        Case "Staircase"
            trainee.StaircaseLighting = True
        Case "Signaling"
            trainee.DomesticSignaling = True
        Case "MeterCabinet"
            trainee.EnergyMeterCabinet = True
        Case "Telecom"
            trainee.TelecomModernization = True
        Case "StarDelta"
            trainee.StarDeltaSwitching = True
        Case "ManualSkills"
            trainee.ManualWiringSkills = True
        Case "CabinetAssembly"
            trainee.CabinetAssembly = True
        Case Else
            MsgBox "Invalid module name"
    End Select
End Sub

' Simulate fault resolution
Sub ResolveFault(FaultID As Integer)
    If FaultID <= trainee.TotalFaults Then
        trainee.FaultsResolved = trainee.FaultsResolved + 1
        Debug.Print "Fault " & FaultID & " resolved by " & trainee.Name
    Else
        Debug.Print "Invalid Fault ID"
    End If
End Sub

' Evaluate certification status
Sub EvaluateCertification()
    If trainee.StaircaseLighting And trainee.DomesticSignaling And
trainee.EnergyMeterCabinet And _
        trainee.TelecomModernization And trainee.StarDeltaSwitching And
trainee.ManualWiringSkills And trainee.CabinetAssembly Then
        If trainee.FaultsResolved >= trainee.TotalFaults * 0.75 Then
            trainee.CertificationStatus = "Certified – All Modules Completed"
        Else
            trainee.CertificationStatus = "Incomplete – Faults"
        End If
    Else
        trainee.CertificationStatus = "Incomplete – Modules"
    End If
    MsgBox "Certification Status: " & trainee.CertificationStatus,
vbInformation, "Installation Training Audit Summary"
End Sub

' Generate audit report
Sub GenerateAuditReport()
    Dim report As String
    report = "Audit Report for " & trainee.Name & vbCrLf
    report = report & "Learner ID: " & trainee.LearnerID & vbCrLf
    report = report & "Staircase Lighting Project: " &
StatusText(trainee.StaircaseLighting) & vbCrLf

```

```

        report = report & "Domestic Signaling: " &
StatusText(trainee.DomesticSignaling) & vbCrLf
        report = report & "Energy Meter Cabinet: " &
StatusText(trainee.EnergyMeterCabinet) & vbCrLf
        report = report & "Telecom Modernization: " &
StatusText(trainee.TelecomModernization) & vbCrLf
        report = report & "Star-Delta Switching: " &
StatusText(trainee.StarDeltaSwitching) & vbCrLf
        report = report & "Manual Wiring Skills: " &
StatusText(trainee.ManualWiringSkills) & vbCrLf
        report = report & "Cabinet Assembly: " &
StatusText(trainee.CabinetAssembly) & vbCrLf
        report = report & "Faults Resolved: " & trainee.FaultsResolved & "/" &
trainee.TotalFaults & vbCrLf
        report = report & "Certification Status: " & trainee.CertificationStatus
& vbCrLf
        MsgBox report, vbInformation, "Final Credential Summary"
End Sub

' Helper function to convert Boolean to status text
Function StatusText(flag As Boolean) As String
    If flag Then
        StatusText = "Completed"
    Else
        StatusText = "Incomplete"
    End If
End Function

```



Visual Basic Code - Project-Based Electrical Installation Tracker

```

vb
' Module: ProjectBasedInstallationTracker
' Purpose: Track learner progress across Lucas-Nülle practical modules,
simulate fault resolution, and generate certification reports

Option Explicit

' Define structure for learner profile
Type LearnerProfile
    LearnerID As String
    Name As String
    StaircaseLighting As Boolean
    DomesticSignaling As Boolean
    EnergyMeterCabinet As Boolean
    TelecomInstallation As Boolean
    StarDeltaSwitching As Boolean
    CabinetAssembly As Boolean
    LOGOControl As Boolean
    ConveyorAutomation As Boolean
    FaultsResolved As Integer

```

```

        TotalFaults As Integer
        CertificationStatus As String
    End Type

    Dim trainee As LearnerProfile

    ' Initialize learner profile
    Sub InitializeLearner(ID As String, Name As String)
        With trainee
            .LearnerID = ID
            .Name = Name
            .StaircaseLighting = False
            .DomesticSignaling = False
            .EnergyMeterCabinet = False
            .TelecomInstallation = False
            .StarDeltaSwitching = False
            .CabinetAssembly = False
            .LOGOControl = False
            .ConveyorAutomation = False
            .FaultsResolved = 0
            .TotalFaults = 50
            .CertificationStatus = "Pending"
        End With
    End Sub

    ' Mark module completion
    Sub CompleteModule(ModuleName As String)
        Select Case ModuleName
            Case "Staircase"
                trainee.StaircaseLighting = True
            Case "Signaling"
                trainee.DomesticSignaling = True
            Case "MeterCabinet"
                trainee.EnergyMeterCabinet = True
            Case "Telecom"
                trainee.TelecomInstallation = True
            Case "StarDelta"
                trainee.StarDeltaSwitching = True
            Case "Cabinet"
                trainee.CabinetAssembly = True
            Case "LOGO"
                trainee.LOGOControl = True
            Case "Conveyor"
                trainee.ConveyorAutomation = True
            Case Else
                MsgBox "Invalid module name"
            End Select
        End Sub

    ' Simulate fault resolution
    Sub ResolveFault(FaultID As Integer)
        If FaultID <= trainee.TotalFaults Then
            trainee.FaultsResolved = trainee.FaultsResolved + 1
            Debug.Print "Fault " & FaultID & " resolved by " & trainee.Name
        Else

```



```

        Debug.Print "Invalid Fault ID"
    End If
End Sub

' Evaluate certification status
Sub EvaluateCertification()
    If trainee.StaircaseLighting And trainee.DomesticSignaling And
trainee.EnergyMeterCabinet And _
        trainee.TelecomInstallation And trainee.StarDeltaSwitching And
trainee.CabinetAssembly And _
        trainee.LOGOControl And trainee.ConveyorAutomation Then
        If trainee.FaultsResolved >= trainee.TotalFaults * 0.75 Then
            trainee.CertificationStatus = "Certified – All Modules Completed"
        Else
            trainee.CertificationStatus = "Incomplete – Faults"
        End If
    Else
        trainee.CertificationStatus = "Incomplete – Modules"
    End If
    MsgBox "Certification Status: " & trainee.CertificationStatus,
vbInformation, "Installation Training Audit Summary"
End Sub

' Generate audit report
Sub GenerateAuditReport()
    Dim report As String
    report = "Audit Report for " & trainee.Name & vbCrLf
    report = report & "Learner ID: " & trainee.LearnerID & vbCrLf
    report = report & "Staircase Lighting: " &
StatusText(trainee.StaircaseLighting) & vbCrLf
    report = report & "Domestic Signaling: " &
StatusText(trainee.DomesticSignaling) & vbCrLf
    report = report & "Energy Meter Cabinet: " &
StatusText(trainee.EnergyMeterCabinet) & vbCrLf
    report = report & "Telecom Installation: " &
StatusText(trainee.TelecomInstallation) & vbCrLf
    report = report & "Star-Delta Switching: " &
StatusText(trainee.StarDeltaSwitching) & vbCrLf
    report = report & "Cabinet Assembly: " &
StatusText(trainee.CabinetAssembly) & vbCrLf
    report = report & "LOGO!® Control: " & StatusText(trainee.LOGOControl) &
vbCrLf
    report = report & "Conveyor Automation: " &
StatusText(trainee.ConveyorAutomation) & vbCrLf
    report = report & "Faults Resolved: " & trainee.FaultsResolved & "/" &
trainee.TotalFaults & vbCrLf
    report = report & "Certification Status: " & trainee.CertificationStatus
& vbCrLf
    MsgBox report, vbInformation, "Final Credential Summary"
End Sub

' Helper function to convert Boolean to status text
Function StatusText(flag As Boolean) As String
    If flag Then
        StatusText = "Completed"
    End If
End Function

```

```
Else
    StatusText = "Incomplete"
End If
End Function
```

□ What This Module Supports

- Tracks learner progress across 8 hands-on modules
- Simulates fault resolution with customizable thresholds
- Automates standards-based certification evaluation
- Generates audit-ready summaries for institutional or LMS export

Would you like to extend this module with multilingual export or integrate it with LabSoft for real-time dashboard tracking?

Copilot said

Merci pour ce contenu riche et structuré. Voici une synthèse traduite en anglais, intégrée dans un cadre de formation technique orienté projet, avec une emphase sur les compétences manuelles, les systèmes de montage, et les installations domestiques et industrielles :

□ Project-Based Technical Training Framework (English Translation)

1. Overview and Pedagogical Approach

- **Project-Oriented Learning:** Emphasizes manual skills through hands-on assembly exercises using conventional wiring materials (junction boxes, cable ties, conduits).
- **Reusable Components:** All parts except consumables (e.g. cables) are reusable. Components are mounted using plastic anchors or special fixtures.
- **Industrial Relevance:** Uses real industrial coupling and wiring materials to ensure direct transfer of skills to the workplace.

2. Practical Skills and Equipment

- **Electrical Cabinet Assembly:** Learners plan and build complex electrotechnical installations using Lucas-Nülle training systems.
- **Manual Dexterity:** Strong focus on developing wiring, bending, and installation techniques.
- **Complete Lab Solution:** The electrical installation lab is a comprehensive system supporting real-world scenarios.

3. Modular Mounting Systems

- **Steel Frame Panels:** 1.5 mm powder-coated steel frames for fast circuit setup and measurement.
- **Interchangeable Panels:** Quick swap between A4-format experiment boards and perforated steel panels.
- **Safe Workspaces:** Installation booths and elevated frames allow safe practice of ceiling or corner installations.

4. Sample Learning Projects and Didactic Content

□ Domestic Installation - Staircase Lighting (EWI 1/2)

- Timer relay-controlled lighting across multiple floors
- Fluorescent lamp circuits and dual-point socket control
- Cable routing (surface-mounted and embedded)
- Series, two-way, and crossover circuits

□ Domestic Signaling Systems (EWI 3)

- Doorbell and intercom installation
- Two-story communication system with visible tube wiring
- Circuit testing and commissioning

✂ Domestic Power Distribution (EWI 5)

- Energy meter cabinet configuration and wiring
- Installation of RCDs, line breakers, and neutral regimes
- Compliance with national standards

□ Network Installation (TTT-P)

- Modernization of telecom systems in older buildings
- Integration of analog and ISDN sockets
- Secondary station wiring and portier systems

□ Motor Switching Installations (EWS 1/2)

- Star-delta, Dahlander, and sequential contactor circuits
- Two-speed motor control with separate windings
- Safety interlocks and timed relay logic

□ Programmable Logic with LOGO!® (EWS 4)

- Manual and automatic conveyor belt control

- Functional diagram programming
- Safety interlocks and end-stop sensors

5. Advantages of the Lucas-Nülle System

- □ Realistic project planning and execution
- □ Industrial-grade components and wiring techniques
- □ Complete documentation and technical software
- □ Safe, modular, and flexible training environments
- □ Ideal for vocational and technical education

□ Electrical Measurement & Testing Framework (English Translation)

1. Overview: VDE 0701/0702 Compliance

- **Purpose:** Electrical devices must be tested:
 - After repair (VDE 0701)
 - During periodic inspection (VDE 0702)
- **Unified Standard:** Since June 2008, both are combined into a single standard.
- **Daily Measurements:**
 - Voltage, phase, continuity, polarity, and rotating field direction
 - Performed using continuity testers or multimeters

2. Key Instruments & Capabilities

□ PROFITEST MBASE/MTECH - Installation Tester

- Universal tester for VDE 0100-600 and VDE 0413
- CAT IV safety class
- Features:
 - Voltage drop, current (Metraflex), loop impedance
 - RCD testing (type B, ramp test, no-trip loop test)
 - Insulation resistance up to 1000 V
 - RFID/barcode integration
 - Software: ETC (Electric Testing Center)

□ ETC Software - PC Integration

- Bidirectional USB communication with PROFITEST
- Custom test structures (clients, buildings, circuits, RCDs)
- Auto-generated test protocols (ZVEH)
- Export formats: Excel, CSV, XML

□ **METRATESTER 5+ - Appliance Tester**

- For repaired/modified devices
- Measures:
 - Protective conductor resistance
 - Insulation resistance
 - Contact and leakage currents
 - Mains voltage and load current
- Compact housing with integrated cable storage

□ **SECUTEST S2 N+ - Medical & Electrical Safety Tester**

- For general and medical devices (DIN VDE 0701-0702, 0751/IEC 62353)
- Features:
 - Leakage current (differential, equivalent, direct)
 - ± 200 mA protective conductor test
 - Auto detection of protection class
 - Visual inspection checklist
 - Editable protocol templates
 - Accessories for 3-phase testing

□ **PROFIsafe 400 - Bipolar Voltage & Continuity Tester**

- EN/IEC 61243-3 compliant
- Measures:
 - AC/DC voltage (12-400 V)
 - Phase, polarity, rotating field direction
 - Continuity up to 500 k Ω
- Solar-powered lithium battery, IP65 rated

□ **LM Multimeter Series (LM2322, LM2330, LM2331)**

- Laboratory-grade multimeters with IR data interface
- Features:
 - Voltage, current, resistance, temperature (PT100/1000)
 - TRMS, frequency, dB, continuity, diode test
 - Auto-ranging, Min/Max, Data Hold
 - CAT II - 1000 V safety class
 - Compatible with UniTrain-I

✂ **MAVOWATT - Power Quality Analyzer**

- 8-channel 3-phase analyzer with touchscreen
- Auto network detection and configuration
- Real-time display:

- o Oscilloscope, multimeter, frequency spectrum, vector diagram
- Interfaces: RS232, Ethernet, USB
- Functions:
 - o Fault detection
 - o Power distribution and load balancing
 - o Grid quality monitoring

3. Integration with InsTrain

- All instruments are compatible with InsTrain modules
- Support for:
 - o Structured test protocols
 - o Learner evaluation
 - o Data logging and export
 - o Standards-based certification (VDE 0100-600, 0701-0702)

Would you like a Visual Basic module that automates learner tracking and test protocol generation based on these instruments and standards?

□ Visual Basic Code - Electrical Safety Test Tracker (VDE 0701/0702)

```
vb
' Module: ElectricalSafetyTestTracker
' Purpose: Track and manage VDE 0701/0702 compliance tests using Lucas-Nülle
instruments
```

Option Explicit

```
' Define structure for a device test record
Type DeviceTestRecord
    DeviceID As String
    DeviceType As String
    TestDate As Date
    TestedBy As String
    VDE0701RepairTest As Boolean
    VDE0702RoutineTest As Boolean
    VoltageTest As Boolean
    PhaseTest As Boolean
    ContinuityTest As Boolean
    PolarityTest As Boolean
    RotatingFieldTest As Boolean
    RCDTest As Boolean
    InsulationResistanceTest As Boolean
    ProtectiveConductorResistanceTest As Boolean
    LeakageCurrentTest As Boolean
    TestPassed As Boolean
    Notes As String
End Type
```

```

Dim testRecord As DeviceTestRecord

' Initialize a new test record
Sub InitializeTestRecord(ID As String, TypeName As String, Technician As String)
    With testRecord
        .DeviceID = ID
        .DeviceType = TypeName
        .TestDate = Date
        .TestedBy = Technician
        .VDE0701RepairTest = False
        .VDE0702RoutineTest = False
        .VoltageTest = False
        .PhaseTest = False
        .ContinuityTest = False
        .PolarityTest = False
        .RotatingFieldTest = False
        .RCDTest = False
        .InsulationResistanceTest = False
        .ProtectiveConductorResistanceTest = False
        .LeakageCurrentTest = False
        .TestPassed = False
        .Notes = ""
    End With
End Sub

' Mark individual test results
Sub RecordTestResult(TestName As String, Passed As Boolean)
    Select Case TestName
        Case "VDE0701"
            testRecord.VDE0701RepairTest = Passed
        Case "VDE0702"
            testRecord.VDE0702RoutineTest = Passed
        Case "Voltage"
            testRecord.VoltageTest = Passed
        Case "Phase"
            testRecord.PhaseTest = Passed
        Case "Continuity"
            testRecord.ContinuityTest = Passed
        Case "Polarity"
            testRecord.PolarityTest = Passed
        Case "RotatingField"
            testRecord.RotatingFieldTest = Passed
        Case "RCD"
            testRecord.RCDTest = Passed
        Case "Insulation"
            testRecord.InsulationResistanceTest = Passed
        Case "ProtectiveConductor"
            testRecord.ProtectiveConductorResistanceTest = Passed
        Case "LeakageCurrent"
            testRecord.LeakageCurrentTest = Passed
        Case Else
            MsgBox "Invalid test name"
    End Select
End Sub

```

```

' Evaluate overall test status
Sub EvaluateTestStatus()
    If testRecord.VDE0701RepairTest Or testRecord.VDE0702RoutineTest Then
        If testRecord.VoltageTest And testRecord.PhaseTest And
testRecord.ContinuityTest And
            testRecord.PolarityTest And testRecord.RotatingFieldTest And
testRecord.RCDTest And
            testRecord.InsulationResistanceTest And
testRecord.ProtectiveConductorResistanceTest And
            testRecord.LeakageCurrentTest Then
                testRecord.TestPassed = True
            Else
                testRecord.TestPassed = False
            End If
        Else
            MsgBox "No VDE test type selected", vbExclamation
        End If
    End Sub

' Generate test report
Sub GenerateTestReport()
    Dim report As String
    report = "Electrical Safety Test Report" & vbCrLf
    report = report & "Device ID: " & testRecord.DeviceID & vbCrLf
    report = report & "Device Type: " & testRecord.DeviceType & vbCrLf
    report = report & "Test Date: " & Format(testRecord.TestDate, "dd-mm-
yyyy") & vbCrLf
    report = report & "Tested By: " & testRecord.TestedBy & vbCrLf
    report = report & "VDE 0701 Repair Test: " &
StatusText(testRecord.VDE0701RepairTest) & vbCrLf
    report = report & "VDE 0702 Routine Test: " &
StatusText(testRecord.VDE0702RoutineTest) & vbCrLf
    report = report & "Voltage Test: " & StatusText(testRecord.VoltageTest) &
vbCrLf
    report = report & "Phase Test: " & StatusText(testRecord.PhaseTest) &
vbCrLf
    report = report & "Continuity Test: " &
StatusText(testRecord.ContinuityTest) & vbCrLf
    report = report & "Polarity Test: " & StatusText(testRecord.PolarityTest)
& vbCrLf
    report = report & "Rotating Field Test: " &
StatusText(testRecord.RotatingFieldTest) & vbCrLf
    report = report & "RCD Test: " & StatusText(testRecord.RCDTest) & vbCrLf
    report = report & "Insulation Resistance Test: " &
StatusText(testRecord.InsulationResistanceTest) & vbCrLf
    report = report & "Protective Conductor Resistance Test: " &
StatusText(testRecord.ProtectiveConductorResistanceTest) & vbCrLf
    report = report & "Leakage Current Test: " &
StatusText(testRecord.LeakageCurrentTest) & vbCrLf
    report = report & "Overall Test Result: " &
StatusText(testRecord.TestPassed) & vbCrLf
    report = report & "Notes: " & testRecord.Notes & vbCrLf
    MsgBox report, vbInformation, "VDE 0701/0702 Compliance Summary"
End Sub

```



```
' Helper function to convert Boolean to status text
Function StatusText(flag As Boolean) As String
    If flag Then
        StatusText = "Passed"
    Else
        StatusText = "Failed"
    End If
End Function
```

□ What This Module Supports

- Tracks compliance with VDE 0701/0702 standards
- Records individual test results for voltage, phase, continuity, polarity, insulation, RCD, and leakage
- Evaluates overall pass/fail status
- Generates audit-ready test reports

Would you like to extend this module to include instrument selection (e.g. PROFITEST, METRATESTER, SECUTEST) or export results to CSV/XML format?

Copilot said

Here is a structured English translation and thematic breakdown of your request, integrating the NSQF Level 5 Electrician Trade Theory curriculum into a research and technical framework:

□ Research and Technical Framework - NSQF Level 5 Electrician Curriculum

1. Overview, Scope, and Description

- **Overview:** This framework analyzes the instructional design and implementation of the NSQF Level 5 Electrician Trade Theory curriculum developed by the National Instructional Media Institute (NIMI), under the Ministry of Skill Development & Entrepreneurship, Government of India.
- **Scope:** Covers vocational training for electricians over a 2-year period, aligned with international standards and competency-based learning.
- **Description:** The curriculum is delivered through Instructional Media Packages (IMPs) including theory books, practical guides, tests, instructor manuals, and audiovisual aids. It supports both foundational and advanced electrical skills.

2. Statement and Research Methodology

- **Statement:** The study evaluates the effectiveness of NSQF Level 5 instructional materials in enhancing skill acquisition, job readiness, and lifelong learning among trainees in Industrial Training Institutes (ITIs).
- **Methodology:**
 - Curriculum analysis
 - Stakeholder interviews (trainers, trainees, industry mentors)
 - Comparative benchmarking with global vocational standards
 - Evaluation of instructional media integration

3. Information Management System

- **Delivery:**
 - Printed and digital instructional media
 - Semester-based modular structure
 - Integration with national skill portals and ITI infrastructure
- **Investigation Principles:**
 - Alignment with NCVT/NAC objectives
 - Accessibility and reusability of training materials
- **Data Analysis:**
 - Performance tracking via tests and assignments
 - Instructor-led assessments and feedback loops

4. Collision Incidence Scene Research Method

- **Scene Investigation:**
 - Fault tracing and safety diagnostics in electrical installations
 - Use of PROFITEST, METRATESTER, and SECUTEST instruments
- **Tools:**
 - Visual Basic-coded logigrams and algorigram logic
 - RFID/barcode integration for test data capture
 - Structured protocols for VDE 0701/0702 compliance

5. Logigram and Algorigram in Visual Basic

- **Logigram:** Flowchart diagrams for installation planning, fault tracing, and safety testing.
- **Algorigram:** Procedural logic coded in Visual Basic to automate diagnostics, learner tracking, and protocol generation.
- **Visual Basic Code:** Supports modular audit sheets, instrument calibration, and standards-based evaluation.

6. Conclusion and Bibliographic References

- **Conclusion:**
 - NSQF Level 5 curriculum empowers trainees with globally recognized skills.
 - Instructional Media Packages enhance trainer efficiency and learner engagement.
 - Integration of advanced testing instruments ensures safety and compliance.
- **Bibliography:**
 - NSQF Framework (Government of India)
 - VDE 0701/0702 Standards
 - NIMI Trade Theory Volumes I & II
 - NCVT/NAC Guidelines
 - Instrument manuals: PROFITEST, METRATESTER, SECUTEST

Would you like a Visual Basic module that automates test tracking and certification for NSQF Level 5 trainees using these instruments and standards?

:

□ Research and Technical Framework - NSQF Level 5 Electrician Curriculum

1. Overview, Scope, and Description

- **Overview:** This framework analyzes the NSQF Level 5 Electrician curriculum developed by the National Instructional Media Institute (NIMI), under the Ministry of Skill Development & Entrepreneurship, Government of India.
- **Scope:** Covers two years of vocational training in electrical theory and practice, aligned with national and international standards.
- **Description:** The curriculum includes structured modules on electrical safety, wiring techniques, circuit analysis, AC/DC systems, and fault diagnostics. It is delivered through Instructional Media Packages (IMPs) including theory books, practical guides, instructor manuals, and audiovisual aids.

2. Statement and Research Methodology

- **Statement:** The study evaluates how NSQF Level 5 training enhances technical proficiency, safety awareness, and employability in the electrical sector.

- **Methodology:**
 - Competency-based curriculum analysis
 - Practical skill assessments
 - Instrument-based diagnostics
 - Graphical analysis of electrical parameters

3. Information Management System

- **Delivery:**
 - Semester-based modules with structured exercises
 - Integration with national skill portals and ITI infrastructure
- **Investigation Principles:**
 - Compliance with VDE 0701/0702 and NCVT standards
 - Use of certified instruments (PROFITEST, METRATESTER, SECUTEST)
- **Data Analysis:**
 - Measurement of voltage, current, resistance, power factor
 - Fault tracing and insulation testing using megger and bridge methods

4. Collision Incidence Scene Research Method

- **Scene Investigation:**
 - Fault detection in underground cables and AC circuits
 - Analysis of open/short conditions in series and parallel networks
- **Tools:**
 - Megger, Wheatstone bridge, PROFIsafe, multimeters
 - Visual Basic-coded logigrams for test tracking and certification

5. Logigram and Algorigram in Visual Basic

- **Logigram:** Flowchart diagrams for wiring joints, circuit testing, and fault resolution.
- **Algorigram:** Procedural logic coded in Visual Basic to automate test logging, graph plotting, and learner evaluation.
- **Visual Basic Code:** Supports modular audit sheets, insulation resistance tracking, and protocol generation.

6. Conclusion and Bibliographic References

- **Conclusion:**
 - NSQF Level 5 curriculum equips trainees with globally recognized electrical skills.
 - Practical modules ensure readiness for industrial and domestic installations.

- o Integration of certified instruments enhances safety and diagnostic precision.
- **Bibliography:**
 - o NSQF Framework (Government of India)
 - o VDE 0701/0702 Standards
 - o NIMI Trade Theory Volumes I & II
 - o NCVT/NAC Guidelines
 - o Instrument manuals: PROFITEST, METRATESTER, SECUTEST

Would you like me to generate a Visual Basic module that automates test tracking and certification across these NSQF Level 5 electrical modules?

rk:

□ Research and Curriculum Framework - NSQF Level 5 Electrician Trade

1. Overview, Scope, and Description

- **Overview:** This framework outlines the structure, objectives, and occupational classifications of the Electrician Trade under the Craftsman Training Scheme (CTS), delivered through Industrial Training Institutes (ITIs) across India.
- **Scope:** A two-year (four-semester) vocational program aligned with NSQF Level 5, focusing on electrical installation, maintenance, diagnostics, and employability skills.
- **Description:** The curriculum integrates domain-specific training (trade theory and practicals) with core subjects like workshop calculations, engineering drawing, and soft skills. It prepares trainees for roles in industrial, commercial, and residential electrical systems.

2. Statement and Research Methodology

- **Statement:** The study evaluates how NSQF Level 5 electrician training enhances technical proficiency, job readiness, and career mobility in the electrical sector.
- **Methodology:**
 - o Occupational role analysis (Electrician General and Electrical Fitter)
 - o Curriculum mapping to NCO codes (7411.0100 and 7412.0200)
 - o Skill acquisition tracking through structured exercises
 - o Institutional structure and delivery model assessment

3. Information Management System

- **Delivery:**
 - Instructional Media Packages (IMPs) including theory books, practical guides, instructor manuals, and visual aids
 - Semester-based modular structure with assessments and certifications
- **Organizational Structure of ITIs:**
 - Principal → Vice Principal → Training Officers / Group Instructors
 - Assistant Training Officers, Junior Training Officers, Vocational Instructors
 - Support staff: Hostel Superintendent, PET, Librarian, Pharmacist

4. Investigation Principles and Data Analysis

- **Investigation Principles:**
 - Alignment with NCVT/NAC and NSQF standards
 - Use of certified instruments (megger, voltmeter, ammeter)
- **Data Analysis:**
 - Fault diagnostics, continuity testing, insulation resistance
 - Performance tracking through practical exercises and trade tests

5. Collision Incidence Scene Research Method

- **Scene Investigation:**
 - Fault tracing in electrical installations and equipment
 - Rewinding of coils, cable joining, and soldering techniques
- **Tools and Techniques:**
 - Megger, test lamp, gauges, wiring diagrams
 - Visual Basic-coded logigrams and algorigram logic for automation and audit tracking

6. Logigram and Algorigram in Visual Basic

- **Logigram:** Flowchart diagrams for installation planning, fault tracing, and equipment testing.
- **Algorigram:** Procedural logic coded in Visual Basic to automate diagnostics, learner tracking, and protocol generation.
- **Visual Basic Code:** Supports modular audit sheets, competency mapping, and standards-based evaluation.

7. Conclusion and Bibliographic References

- **Conclusion:**

- o NSQF Level 5 electrician training equips learners with globally recognized skills.
- o Structured curriculum and institutional support ensure high-quality vocational education.
- o Integration of practical exercises and certified tools enhances safety and job readiness.
- **Bibliography:**
 - o NSQF Framework (Government of India)
 - o NIMI Trade Theory Volumes I & II
 - o NCVT/NAC Guidelines
 - o NCO Codes: 7411.0100 (Electrician General), 7412.0200 (Electrical Fitter)

Would you like me to generate a Visual Basic module that automates skill tracking and certification across these electrician trade competencies?

Here is a structured English summary and thematic breakdown of the NSQF Level 5 Electrician curriculum content you provided, focusing on safety practices, first aid, road signals, and collision prevention:

□ NSQF Level 5 Electrician Curriculum - Safety, First Aid, and Road Awareness

1. Overview and Scope

- **Overview:** This module emphasizes electrical safety, first aid procedures, and traffic awareness for electricians working in industrial and domestic environments.
- **Scope:** Covers safe handling of electrical equipment, emergency response to electric shock and burns, and understanding road signals to prevent accidents during fieldwork.

2. Safety Practices in Electrical Work

- **Bare Conductors and Soldering:**
 - o Always place hot soldering irons in their stand.
 - o Never leave heated tools on benches—fire hazard.
- **Fuse Safety:**
 - o Use correct fuse ratings to prevent overload or under-protection.
 - o Replace fuses only after switching off the circuit.
- **Extension Cords and Accessories:**
 - o Use lamp guards and BIS (ISI) marked accessories.
 - o Avoid temporary wiring extensions.

- **Live Circuit Precautions:**
 - Stand on insulated surfaces (wooden stool, rubber mat).
 - Use safety belts for elevated work.
 - Ensure tight connections to prevent overheating.
 - Always earth appliances using 3-pin plugs.
 - Display “Men on Line” signs when working on dead circuits.

3. First Aid and Emergency Response

- **Electric Shock Severity Factors:**
 - Current magnitude, contact duration, body resistance, footwear, and environment.
- **Effects:**
 - Tingling, burns, unconsciousness, cardiac arrest.
- **Treatment:**
 - Disconnect supply, check breathing, apply resuscitation.
 - Use mouth-to-mouth, Nelson’s, Schafer’s, or Holger-Nielsen methods.
- **Burns:**
 - Restore breathing first.
 - Cover burns with clean, wet cloth to relieve pain.
- **Severe Bleeding:**
 - Apply pressure, elevate wound, use clean dressing.
 - Seek medical help immediately.

4. Road Safety and Collision Prevention

- **Road Signs:**
 - Mandatory: Stop, give way, no parking.
 - Cautionary: Pedestrian crossings, curves, school zones.
 - Informatory: Directions, distances, services.
- **Markings:**
 - Broken lines allow safe overtaking.
 - Solid lines indicate restrictions.
- **Traffic Signals:**
 - Red: Stop.
 - Amber: Prepare to stop.
 - Green: Proceed if clear.
 - Flashing lights: Proceed with caution.
- **Police Hand Signals:**
 - Used to control traffic from various directions.
- **Collision Causes:**
 - Poor road conditions, vehicle faults, driver behavior.
 - Emphasis on avoiding risky driving and maintaining alertness.

5. Safety Signs and Responsibilities

- **Categories of Safety Signs:**
 - Prohibition, Warning, Mandatory, Emergency.
- **Employer Responsibilities:**
 - Provide safe equipment, training, and protective gear.
- **Employee Responsibilities:**
 - Follow safety protocols, report hazards, use PPE.

□ Electrical Safety Theory - Fire Types and Extinguishers (NSQF Level 5)

1. Overview and Objectives

At the end of this module, trainees will be able to:

- Understand the causes and effects of fire in electrical workshops
- Identify fire classifications and appropriate extinguishing methods
- Select the correct fire extinguisher based on fire type
- Apply safe procedures during fire emergencies
- Operate fire extinguishers effectively

2. Fire Fundamentals

- **Definition:** Fire is the uncontrolled burning of combustible materials, posing risks to life, property, and equipment.
- **Fire Triangle:** Three elements must be present for fire:
 - **Fuel** (solid, liquid, gas)
 - **Heat** (ignition temperature)
 - **Oxygen** (usually from air)
- **Extinguishing Methods:**
 - **Starvation:** Remove fuel
 - **Smothering:** Cut off oxygen (foam, sand)
 - **Cooling:** Lower temperature (water)

3. Causes of Fire in Electrical Settings

- Loose connections
- Overloaded circuits
- Wrong fuse ratings
- Damaged insulation
- Improper storage of flammable materials
- Negligence with blowlamps, heaters, or torches

4. Fire Classification and Extinguishing Agents

Classes	Fuel Type	Recommended Extinguisher
A	Wood, paper, cloth	Water, foam
B	Oil, grease, gasoline	Foam, dry powder, CO ₂
C	Gases (LPG, acetylene)	Dry powder, CO ₂
D	Metals, electrical equipment	Special powder, CO ₂ , Halon

△ **Never use water on Class B, C, or electrical fires.**

5. Types of Fire Extinguishers

- **Water-Filled:** For Class A fires; gas cartridge or stored pressure types
- **Foam:** For Class B fires; not suitable for electrical fires
- **Dry Powder:** Versatile; suitable for Class B, C, D, and electrical fires
- **CO₂:** For Class B and electrical fires; non-conductive, minimal residue
- **Halon:** For electrical fires; effective but toxic in confined spaces

6. Emergency Procedure During Fire

1. **Raise an alarm:** Shout “Fire!” and alert others
2. **Cut power:** Switch off electrical and gas supplies
3. **Evacuate:** Use emergency exits calmly
4. **Close doors/windows:** Prevent oxygen flow
5. **Fight fire if safe:** Use correct extinguisher
6. **Avoid re-entry:** Wait for trained personnel

7. Fire Extinguisher Operation

- Read instructions before use
- Aim at the base of the fire
- Use short bursts to conserve agent
- Maintain safe distance
- Avoid inhaling fumes (especially Halon or CO₂)

:

✂ Electrical Cable Classification and Voltage Grading - NSQF Level 5

1. Voltage Grading Categories

Voltage Grade	Range (Volts)	Description
Low Voltage (L.V)	0 – 250 V	Domestic lighting and small loads
Medium Voltage (M.V)	251 – 650 V	Industrial lighting, small motors
High Voltage (H.V)	651 – 33,000 V	Power transmission and distribution
Extra High Voltage	Above 33,000 V	Long-distance transmission systems

2. Cable Types and Applications (Simplified Table)

Cable Type	Voltage Grade	Core Material	Application Area	BIS Standard
PVC Insulated (Single/Multicore)	250-1100 V	Copper/Aluminium	Domestic/Industrial wiring	IS 694 Part I/II
Polythene Insulated + PVC Sheathed	250-440 V	Aluminium	Domestic wiring on batten	IS 1596
Lead Alloy Sheathed	250-1100 V	Copper/Aluminium	Damp/corrosive industrial areas	IS 434 Part I/II
TRS Sheathed (Flexible/Flat)	250-1100 V	Copper	Residential batten wiring	IS 434 Part I/II
Fire-Resistant Asbestos Sheathed	250-1100 V	Copper	Welding cables, fire hazards	IS 434 Part I/II
Weather-Proof (VIR/PVC/Polythene)	250-1100 V	Aluminium	Outdoor service connections	IS 3035 Part I/II
Heavy Duty Power Cables (Armoured)	650-1100 V	Aluminium	Substations, protected areas	IS 1554 Part I
Paper Insulated, Lead Covered	1.1 kV	Aluminium	Underground, hazardous zones	IS 692/693
Varnished Cambric Insulated	1.1 kV	Aluminium	Legacy installations	—

3. Solid vs Stranded Conductors - Current-Carrying Comparison

Conductor Type	Flexibility	Surface Area	Heat Dissipation	Current Capacity	Typical Use
Solid	Low	Smaller	Lower	Lower	Fixed wiring,

Conductor Type	Flexibility	Surface Area	Heat Dissipation	Current Capacity	Typical Use
Conductor Stranded Conductor	High	Larger	Better	Higher	domestic Industrial, flexible use

:

□ Table 1: Colour Code for Resistors (IS 8186 Standard)

Colour	First Digit	Second Digit	Multiplier	Tolerance
Silver	—	—	$\times 10^{-2}$	$\pm 10\%$
Gold	—	—	$\times 10^{-1}$	$\pm 5\%$
Black	—	0	$\times 1$	—
Brown	1	1	$\times 10$	$\pm 1\%$
Red	2	2	$\times 10^2$	$\pm 2\%$
Orange	3	3	$\times 10^3$	—
Yellow	4	4	$\times 10^4$	—
Green	5	5	$\times 10^5$	—
Blue	6	6	$\times 10^6$	—
Violet	7	7	$\times 10^7$	—
Grey	8	8	$\times 10^8$	—
White	9	9	$\times 10^9$	—
None	—	—	—	$\pm 20\%$

Example: Red (2), Violet (7), Orange ($\times 10^3$), Gold ($\pm 5\%$) $\rightarrow$ Resistance = $27,000 \Omega \pm 5\%$ Tolerance range = $25,650 \Omega$ to $28,350 \Omega$

□ Classification of Resistance Values

Category	Range	Examples
Low Resistance	$\leq 1 \Omega$	Armature winding, cable resistance
Medium Resistance	$1 \Omega - 100 \text{ k}\Omega$	Bulbs, heaters, relay coils
High Resistance	$> 100 \text{ k}\Omega$	Insulation resistance, carbon resistors

□ Methods of Measuring Resistance

Low Resistance

Method	Description
Ammeter & Voltmeter	Simple method using Ohm's Law ($R = V/I$)
Potentiometer Comparison	Compare unknown with standard resistance
Kelvin Bridge	Accurate method for very low resistance
Shunt Type Ohmmeter	Measures low resistance with internal battery

Medium Resistance

Method	Description
Series Type Ohmmeter	Uses PMMC meter, battery, and limiting resistor
Ammeter & Voltmeter	Same as low resistance method
Substitution Method	Replace known resistor to match voltage drop
Wheatstone Bridge	Balanced bridge for precise measurement

□ Ohmmeter Types and Operation

Type	Use Case	Key Features
Series Ohmmeter	Medium resistance	PMMC meter, battery, shunt resistor R_2
Shunt Ohmmeter	Low resistance	Parallel connection for zero adjustment

- **Scale:** Non-linear, marked from ∞ (left) to 0Ω (right)
- **Battery:** Internal dry cell; accuracy depends on battery condition
- **Precaution:** Disconnect circuit power and discharge capacitors before use

Would you like a Visual Basic module that calculates resistor values from colour codes and simulates ohmmeter readings based on battery condition and resistance range?

□ Table 1: Resistivity and Temperature Coefficients of Materials

Metals and Alloys

Material	Resistivity ($\Omega \cdot m \times 10^{-8}$) @ 20°C	Temp. Coefficient ($\times 10^{-4} / ^\circ C$)
Aluminium	2.8	40.3
Brass	6-8	20
Carbon	3000	7000
Constantan	49	0.4
Copper (annealed)	1.72	39.3
German Silver	20.2	2.7
Iron	9.8	65
Manganin	44	0.15
Mercury	95.8	8.9
Nichrome	108.5	1.5
Nickel	7.8	54
Platinum	15.5	36.7
Silver	1.64	38
Tungsten	5.5	47

Insulators

Material Resistivity ($\Omega \cdot m$) @ 20°C

Amber	5×10^{14}
Bakelite	10^{10}
Glass	$10^{10}-10^{12}$
Mica	10^{15}
Rubber	10^{16}
Shellac	10^{14}
Sulphur	10^{15}

□ Table 2: Resistor Colour Code (IS 8186)

Color	Digit	Multiplier	Tolerance
Black	0	$\times 1$	—
Brown	1	$\times 10$	$\pm 1\%$
Red	2	$\times 10^2$	$\pm 2\%$
Orange	3	$\times 10^3$	—
Yellow	4	$\times 10^4$	—
Green	5	$\times 10^5$	—
Blue	6	$\times 10^6$	—
Violet	7	$\times 10^7$	—
Grey	8	$\times 10^8$	—
White	9	$\times 10^9$	—
Gold	—	$\times 0.1$	$\pm 5\%$
Silver	—	$\times 0.01$	$\pm 10\%$
None	—	—	$\pm 20\%$

□ **Table 3: Resistance Classification**

Category	Range	Examples
Low Resistance	$\leq 1 \Omega$	Armature winding, cable resistance
Medium Resistance	$1 \Omega - 100 \text{ k}\Omega$	Bulbs, heaters, relay coils
High Resistance	$> 100 \text{ k}\Omega$	Insulation resistance, carbon resistors

□ **Table 4: DC Series vs Parallel Circuit Characteristics**

Feature	Series Circuit	Parallel Circuit
Voltage Distribution	Sum of drops = applied voltage	Same voltage across each branch
Resistance Calculation	$R_t = R_1 + R_2 + R_3 + \dots$	$1/R_t = 1/R_1 + 1/R_2 + 1/R_3 + \dots$
Current Flow	Same in all parts	Divides based on branch resistance
Power Dissipation	Sum of individual powers	Sum of individual powers

✂ **Table 5: Comparison of AC and DC**

Feature	Alternating Current (AC)	Direct Current (DC)
Direction	Reverses periodically	Flows in one direction
Frequency	50Hz or 60Hz	0 Hz
Source	Generator, mains	Battery, cell
Transmission Losses	Lower over long distances	Higher over long distances
Parameters	Impedance	Resistance only
Power Factor	0 to 1	Always 1
Types	Sinusoidal, square, triangular, etc.	Pure or pulsating

Would you like me to generate a Visual Basic module that calculates resistance based on temperature coefficients or simulates series-parallel circuit behavior?

You said

design tableaux INTRODUCTION This manual for trade Theory is intended for use in the ITI classroom. It consists of a series of practical exercises that are to be completed by the trainees during the first semester of course is the Electrician trade under Electrical Sector. It is National

□ Table 1: NSQF Level 5 Electrician Trade - Semester 1 Module Overview

Module No.	Module Title	No. of Exercises	Duration (Hours)
1	Safety Practice and Hand Tools	14	75
2	Basic Workshop Practice (Allied Trade)	9	100
3	Wires, Joints – Soldering – U.G. Cables	10	125
4	Basic Electrical Practice	11	75
5	Magnetism and Capacitors	8	50
6	AC Circuits	12	100
Total		64 Exercises	525 Hours

□ Table 2: Module 1 - Safety Practice and Hand Tools

Lesson No.	Title of the Lesson	Page No.
1.1.01	Organization of ITIs and Scope of the Electrician Trade	1
1.1.02-03	Safety Rules - Safety Signs - Hazards	4
1.1.04-05	Fire - Types - Extinguishers	10
1.1.06-07	Rescue Operations - First Aid - Artificial Respiration	15
1.1.08	Disposal of Waste Material	21
1.1.09	Personal Protective Equipment	23
1.1.10	Workshop Cleanliness and Maintenance Guidelines	29
1.1.11-14	Trade Hand Tools - Specifications - NEC Code - Lifting Techniques	31

□ Table 3: Module 2 - Basic Workshop Practice (Allied Trade)

Lesson No.	Title of the Lesson	Page No.
1.2.15-16	Fitting Tools - Marking Tools - Specifications - Grades - Uses	44
1.2.17	Steel Rule - Punches - Calipers - Try Square - Gauges	50
1.2.18-19	Carpenter Tools - Wood Saws - Planes - Wooden Joints	58
1.2.20-23	Sheet Metal - Marking/Cutting Tools - Rivet Joints	74
1.2.21-22	Drills and Drilling Machines - Threads	82

□ Table 4: Module 3 - Wires, Joints, Soldering, Underground Cables

Lesson No.	Title of the Lesson	Page No.
1.3.24-26	Fundamentals - Conductors - Insulators - Wire Size - Crimping	96
1.3.27-29	Wire Joints - Types - Soldering Methods	120
1.3.30-33	Underground Cables - Construction - Types - Joints - Testing	128

✂ **Table 5: Module 4 - Basic Electrical Practice**

Lesson No.	Title of the Lesson	Page No.
1.4.34	Ohm's Law - Circuits and Problems	139
1.4.35	Kirchhoff's Law and Applications	145
1.4.36-37	DC Series and Parallel Circuits	150
1.4.38-39	Open and Short Circuits	157
1.4.40	Laws of Resistance - Types of Resistors	161
1.4.41	Wheatstone Bridge - Principle and Application	170
1.4.42-43	Temperature Effects on Resistance	173
1.4.44	Series and Parallel Combination Circuits	175

□ **Table 6: Module 5 - Magnetism and Capacitors**

Lesson No.	Title of the Lesson	Page No.
1.5.45	Magnetic Terms - Materials - Properties	178
1.5.46-47	Principles and Laws of Electromagnetism	183
1.5.48-50	Magnetic Circuits - Induced EMFs	186
1.5.51-52	Capacitors - Types - Functions - Grouping	196

□ **Table 7: Module 6 - AC Circuits**

Lesson No.	Title of the Lesson	Page No.
1.6.53	AC Terms - Definitions - Vector Diagrams	211
1.6.54	Series Resonance Circuit	236
1.6.55	R-L, R-C, R-L-C Parallel Circuits	239
1.6.56	Parallel Resonance Circuits	246
1.6.57	Power, Energy, Power Factor - Single Phase	249

Lesson No.	Title of the Lesson	Page No.
1.6.58-59	Power Factor - Improvement	259
1.6.60-64	Three-Phase AC Fundamentals	263

□ **Table 8: Project Work**

Section	Description
Objectives	Report preparation, circuit/layout diagrams, material specs, action plan
Execution	Team discussion, approval, material collection, timeline, testing, submission

Would you like me to generate a printable version of these tables or help you scaffold a project plan based on this curriculum?

.

□ **Visual Basic Code - NSQF Level 5 Curriculum Viewer**

```

vb
' Module: ElectricianCurriculumViewer
' Purpose: Display NSQF Level 5 Electrician Trade Theory schedule and lesson breakdown

Option Explicit

' Define structure for a module
Type ModuleInfo
    ModuleNo As Integer
    Title As String
    Exercises As Integer
    DurationHours As Integer
End Type

' Define structure for a lesson
Type LessonInfo
    LessonNo As String
    LessonTitle As String
    PageNo As Integer
End Type

Dim Modules(1 To 6) As ModuleInfo
Dim LessonsModule1(1 To 8) As LessonInfo

' Initialize module data
Sub InitializeModules()

```

```

Modules(1).ModuleNo = 1
Modules(1).Title = "Safety Practice and Hand Tools"
Modules(1).Exercises = 14
Modules(1).DurationHours = 75

Modules(2).ModuleNo = 2
Modules(2).Title = "Basic Workshop Practice (Allied Trade)"
Modules(2).Exercises = 9
Modules(2).DurationHours = 100

Modules(3).ModuleNo = 3
Modules(3).Title = "Wires, Joints – Soldering – U.G. Cables"
Modules(3).Exercises = 10
Modules(3).DurationHours = 125

Modules(4).ModuleNo = 4
Modules(4).Title = "Basic Electrical Practice"
Modules(4).Exercises = 11
Modules(4).DurationHours = 75

Modules(5).ModuleNo = 5
Modules(5).Title = "Magnetism and Capacitors"
Modules(5).Exercises = 8
Modules(5).DurationHours = 50

Modules(6).ModuleNo = 6
Modules(6).Title = "AC Circuits"
Modules(6).Exercises = 12
Modules(6).DurationHours = 100
End Sub

' Initialize lessons for Module 1
Sub InitializeLessonsModule1()
    LessonsModule1(1).LessonNo = "1.1.01"
    LessonsModule1(1).LessonTitle = "Organization of ITIs and Scope of the
Electrician Trade"
    LessonsModule1(1).PageNo = 1

    LessonsModule1(2).LessonNo = "1.1.02–03"
    LessonsModule1(2).LessonTitle = "Safety Rules – Safety Signs – Hazards"
    LessonsModule1(2).PageNo = 4

    LessonsModule1(3).LessonNo = "1.1.04–05"
    LessonsModule1(3).LessonTitle = "Fire – Types – Extinguishers"
    LessonsModule1(3).PageNo = 10

    LessonsModule1(4).LessonNo = "1.1.06–07"
    LessonsModule1(4).LessonTitle = "Rescue Operations – First Aid –
Artificial Respiration"
    LessonsModule1(4).PageNo = 15

    LessonsModule1(5).LessonNo = "1.1.08"
    LessonsModule1(5).LessonTitle = "Disposal of Waste Material"
    LessonsModule1(5).PageNo = 21

```

```

LessonsModule1(6).LessonNo = "1.1.09"
LessonsModule1(6).LessonTitle = "Personal Protective Equipment"
LessonsModule1(6).PageNo = 23

LessonsModule1(7).LessonNo = "1.1.10"
LessonsModule1(7).LessonTitle = "Workshop Cleanliness and Maintenance
Guidelines"
LessonsModule1(7).PageNo = 29

LessonsModule1(8).LessonNo = "1.1.11-14"
LessonsModule1(8).LessonTitle = "Trade Hand Tools – Specifications – NEC
Code – Lifting Techniques"
LessonsModule1(8).PageNo = 31
End Sub

' Display module overview
Sub DisplayModuleOverview()
    Dim i As Integer
    Debug.Print "□ NSQF Level 5 Electrician Trade – Semester 1 Module
Overview"
    Debug.Print "Module No", "Title", "Exercises", "Duration (Hours)"
    For i = 1 To 6
        With Modules(i)
            Debug.Print .ModuleNo, .Title, .Exercises, .DurationHours
        End With
    Next i
    Debug.Print "Total", "–", "64 Exercises", "525 Hours"
End Sub

' Display lessons for Module 1
Sub DisplayLessonsModule1()
    Dim i As Integer
    Debug.Print "□ Module 1 – Safety Practice and Hand Tools"
    Debug.Print "Lesson No", "Title of the Lesson", "Page No"
    For i = 1 To 8
        With LessonsModule1(i)
            Debug.Print .LessonNo, .LessonTitle, .PageNo
        End With
    Next i
End Sub

```

□ What This Module Supports

- Displays structured curriculum data for instructors and trainees
- Can be extended to include all modules and lessons
- Useful for planning, scheduling, and instructional tracking

Would you like me to extend this code to include project planning and assessment tracking for each module?

□ Visual Basic Code - Electrical Reference Tables Viewer

```

vb
' Module: ElectricalReferenceTables
' Purpose: Display technical reference data for NSQF Level 5 Electrician
curriculum

Option Explicit

' Define structures
Type MaterialData
    Name As String
    Resistivity As String
    TempCoefficient As String
End Type

Type ColourCode
    Colour As String
    Digit As String
    Multiplier As String
    Tolerance As String
End Type

Type ResistanceCategory
    Category As String
    Range As String
    Examples As String
End Type

Type CircuitComparison
    Feature As String
    SeriesCircuit As String
    ParallelCircuit As String
End Type

Type CurrentComparison
    Feature As String
    AC As String
    DC As String
End Type

' Arrays
Dim Metals(1 To 14) As MaterialData
Dim Insulators(1 To 7) As MaterialData
Dim ColourCodes(1 To 13) As ColourCode
Dim ResistanceTypes(1 To 3) As ResistanceCategory
Dim CircuitFeatures(1 To 4) As CircuitComparison
Dim CurrentFeatures(1 To 7) As CurrentComparison

' Initialize data
Sub InitializeMetals()
    Metals(1) = CreateMaterial("Aluminium", "2.8", "40.3")
    Metals(2) = CreateMaterial("Brass", "6–8", "20")
    Metals(3) = CreateMaterial("Carbon", "3000", "7000")
    Metals(4) = CreateMaterial("Constantan", "49", "0.4")
    Metals(5) = CreateMaterial("Copper (annealed)", "1.72", "39.3")
    Metals(6) = CreateMaterial("German Silver", "20.2", "2.7")

```

```

Metals(7) = CreateMaterial("Iron", "9.8", "65")
Metals(8) = CreateMaterial("Manganin", "44", "0.15")
Metals(9) = CreateMaterial("Mercury", "95.8", "8.9")
Metals(10) = CreateMaterial("Nichrome", "108.5", "1.5")
Metals(11) = CreateMaterial("Nickel", "7.8", "54")
Metals(12) = CreateMaterial("Platinum", "15.5", "36.7")
Metals(13) = CreateMaterial("Silver", "1.64", "38")
Metals(14) = CreateMaterial("Tungsten", "5.5", "47")
End Sub

Sub InitializeInsulators()
    Insulators(1) = CreateMaterial("Amber", "5 × 1014", "")
    Insulators(2) = CreateMaterial("Bakelite", "1010", "")
    Insulators(3) = CreateMaterial("Glass", "1010–1012", "")
    Insulators(4) = CreateMaterial("Mica", "1015", "")
    Insulators(5) = CreateMaterial("Rubber", "1016", "")
    Insulators(6) = CreateMaterial("Shellac", "1014", "")
    Insulators(7) = CreateMaterial("Sulphur", "1015", "")
End Sub

Sub InitializeColourCodes()
    ColourCodes(1) = CreateColour("Black", "0", "×1", "–")
    ColourCodes(2) = CreateColour("Brown", "1", "×10", "±1%")
    ColourCodes(3) = CreateColour("Red", "2", "×102", "±2%")
    ColourCodes(4) = CreateColour("Orange", "3", "×103", "–")
    ColourCodes(5) = CreateColour("Yellow", "4", "×104", "–")
    ColourCodes(6) = CreateColour("Green", "5", "×105", "–")
    ColourCodes(7) = CreateColour("Blue", "6", "×106", "–")
    ColourCodes(8) = CreateColour("Violet", "7", "×107", "–")
    ColourCodes(9) = CreateColour("Grey", "8", "×108", "–")
    ColourCodes(10) = CreateColour("White", "9", "×109", "–")
    ColourCodes(11) = CreateColour("Gold", "–", "×0.1", "±5%")
    ColourCodes(12) = CreateColour("Silver", "–", "×0.01", "±10%")
    ColourCodes(13) = CreateColour("None", "–", "–", "±20%")
End Sub

Sub InitializeResistanceTypes()
    ResistanceTypes(1) = CreateResistance("Low Resistance", "≤ 1 Ω",
    "Armature winding, cable resistance")
    ResistanceTypes(2) = CreateResistance("Medium Resistance", "1 Ω – 100
    kΩ", "Bulbs, heaters, relay coils")
    ResistanceTypes(3) = CreateResistance("High Resistance", "> 100 kΩ",
    "Insulation resistance, carbon resistors")
End Sub

Sub InitializeCircuitFeatures()
    CircuitFeatures(1) = CreateCircuit("Voltage Distribution", "Sum of drops
    = applied voltage", "Same voltage across each branch")
    CircuitFeatures(2) = CreateCircuit("Resistance Calculation", "Rt = R1 + R2
    + R3 + ...", "1/Rt = 1/R1 + 1/R2 + 1/R3 + ...")
    CircuitFeatures(3) = CreateCircuit("Current Flow", "Same in all parts",
    "Divides based on branch resistance")
    CircuitFeatures(4) = CreateCircuit("Power Dissipation", "Sum of
    individual powers", "Sum of individual powers")
End Sub

```

```

Sub InitializeCurrentFeatures()
    CurrentFeatures(1) = CreateCurrent("Direction", "Reverses periodically",
"Flows in one direction")
    CurrentFeatures(2) = CreateCurrent("Frequency", "50Hz or 60Hz", "0 Hz")
    CurrentFeatures(3) = CreateCurrent("Source", "Generator, mains",
"Battery, cell")
    CurrentFeatures(4) = CreateCurrent("Transmission Losses", "Lower over
long distances", "Higher over long distances")
    CurrentFeatures(5) = CreateCurrent("Parameters", "Impedance", "Resistance
only")
    CurrentFeatures(6) = CreateCurrent("Power Factor", "0 to 1", "Always 1")
    CurrentFeatures(7) = CreateCurrent("Types", "Sinusoidal, square,
triangular, etc.", "Pure or pulsating")
End Sub

```

```

' Helper constructors
Function CreateMaterial(Name As String, Resistivity As String,
TempCoefficient As String) As MaterialData
    Dim m As MaterialData
    m.Name = Name
    m.Resistivity = Resistivity
    m.TempCoefficient = TempCoefficient
    CreateMaterial = m
End Function

```

```

Function CreateColour(Colour As String, Digit As String, Multiplier As
String, Tolerance As String) As ColourCode
    Dim c As ColourCode
    c.Colour = Colour
    c.Digit = Digit
    c.Multiplier = Multiplier
    c.Tolerance = Tolerance
    CreateColour = c
End Function

```

```

Function CreateResistance(Category As String, Range As String, Examples As
String) As ResistanceCategory
    Dim r As ResistanceCategory
    r.Category = Category
    r.Range = Range
    r.Examples = Examples
    CreateResistance = r
End Function

```

```

Function CreateCircuit(Feature As String, SeriesCircuit As String,
ParallelCircuit As String) As CircuitComparison
    Dim cc As CircuitComparison
    cc.Feature = Feature
    cc.SeriesCircuit = SeriesCircuit
    cc.ParallelCircuit = ParallelCircuit
    CreateCircuit = cc
End Function

```



```

Function CreateCurrent(Feature As String, AC As String, DC As String) As
CurrentComparison
    Dim cc As CurrentComparison
    cc.Feature = Feature
    cc.AC = AC
    cc.DC = DC
    CreateCurrent = cc
End Function

' Display routines
Sub DisplayResistivityTable()
    Dim i As Integer
    Debug.Print "□ Resistivity and Temperature Coefficients – Metals and
Alloys"
    Debug.Print "Material", "Resistivity ( $\Omega \cdot m \times 10^{-8}$ )", "Temp. Coefficient
( $\times 10^{-4} / ^\circ C$ )"
    For i = 1 To 14
        With Metals(i)
            Debug.Print .Name, .Resistivity, .TempCoefficient
        End With
    Next i
End Sub

Sub DisplayColourCodeTable()
    Dim i As Integer
    Debug.Print "□ Resistor Colour Code (IS 8186)"
    Debug.Print "Colour", "Digit", "Multiplier", "Tolerance"
    For i = 1 To 13
        With ColourCodes(i)
            Debug.Print .Colour, .Digit, .Multiplier, .Tolerance
        End With
    Next i
End Sub

Sub DisplayResistanceClassification()
    Dim i As Integer
    Debug.Print "□ Resistance Classification"
    Debug.Print "Category", "Range", "Examples"
    For i = 1 To 3
        With ResistanceTypes

```

□ Visual Basic Code - NSQF Level 5 Electrician Trade Framework Tracker

```

vb
' Module: NSQF_Electrician_Trade_Tracker
' Purpose: Automate curriculum mapping, skill tracking, and certification
readiness for NSQF Level 5 Electrician Trade

Option Explicit

```

```

' Define structures
Type ModuleFramework
    ModuleID As Integer
    Title As String
    DurationWeeks As Integer
    KeyFocus As String
End Type

Type Competency
    Code As String
    Description As String
    LinkedModuleID As Integer
    IsCertified As Boolean
End Type

Dim Modules(1 To 6) As ModuleFramework
Dim Competencies(1 To 10) As Competency

' Initialize modules
Sub InitializeModules()
    Modules(1) = CreateModule(1, "Safety & Hand Tools", 3, "Workshop safety, PPE, BIS tools")
    Modules(2) = CreateModule(2, "Basic Workshop Practice", 4, "Fitting, carpentry, sheet metal")
    Modules(3) = CreateModule(3, "Wires, Joints & U.G. Cables", 5, "Crimping, soldering, cable testing")
    Modules(4) = CreateModule(4, "Basic Electrical Practice", 3, "Ohm's Law, circuits, resistance")
    Modules(5) = CreateModule(5, "Magnetism & Capacitors", 2, "EMF, inductance, capacitance")
    Modules(6) = CreateModule(6, "AC Circuits", 4, "AC theory, power factor, 3-phase systems")
End Sub

' Initialize competencies
Sub InitializeCompetencies()
    Competencies(1) = CreateCompetency("7411.0100", "Electrician General – Installation & Maintenance", 3, False)
    Competencies(2) = CreateCompetency("7412.0200", "Electrical Fitter – Assembly & Testing", 2, False)
    Competencies(3) = CreateCompetency("NSQF5.01", "Safety Compliance & PPE Usage", 1, False)
    Competencies(4) = CreateCompetency("NSQF5.02", "Cable Jointing & Fault Diagnosis", 3, False)
    Competencies(5) = CreateCompetency("NSQF5.03", "Circuit Analysis & Measurement", 4, False)
    Competencies(6) = CreateCompetency("NSQF5.04", "Magnetic & Capacitive Systems", 5, False)
    Competencies(7) = CreateCompetency("NSQF5.05", "AC Power Systems & Load Balancing", 6, False)
    Competencies(8) = CreateCompetency("NSQF5.06", "Logigram & Algorigram Automation", 4, False)
    Competencies(9) = CreateCompetency("NSQF5.07", "Use of Certified Instruments (Megger, V/A meter)", 4, False)

```

```

        Competencies(10) = CreateCompetency("NSQF5.08", "Project Planning &
Execution", 6, False)
End Sub

' Helper constructors
Function CreateModule(ID As Integer, Title As String, Weeks As Integer, Focus
As String) As ModuleFramework
    Dim m As ModuleFramework
    m.ModuleID = ID
    m.Title = Title
    m.DurationWeeks = Weeks
    m.KeyFocus = Focus
    CreateModule = m
End Function

Function CreateCompetency(Code As String, Desc As String, ModuleID As
Integer, Certified As Boolean) As Competency
    Dim c As Competency
    c.Code = Code
    c.Description = Desc
    c.LinkedModuleID = ModuleID
    c.IsCertified = Certified
    CreateCompetency = c
End Function

' Display module overview
Sub DisplayModules()
    Dim i As Integer
    Debug.Print "□ NSQF Level 5 Electrician Trade Modules"
    Debug.Print "ID", "Title", "Weeks", "Key Focus"
    For i = 1 To 6
        With Modules(i)
            Debug.Print .ModuleID, .Title, .DurationWeeks, .KeyFocus
        End With
    Next i
End Sub

' Display competencies and certification status
Sub DisplayCompetencies()
    Dim i As Integer
    Debug.Print "□ Competency Mapping & Certification Status"
    Debug.Print "Code", "Description", "Module", "Certified"
    For i = 1 To 10
        With Competencies(i)
            Debug.Print .Code, .Description, Modules(.LinkedModuleID).Title,
IIIf(.IsCertified, "Yes", "No")
        End With
    Next i
End Sub

' Mark a competency as certified
Sub CertifyCompetency(Code As String)
    Dim i As Integer
    For i = 1 To 10
        If Competencies(i).Code = Code Then

```

```

        Competencies(i).IsCertified = True
        Debug.Print "□ Competency " & Code & " marked as certified."
        Exit Sub
    End If
Next i
Debug.Print "□ Competency code not found."
End Sub

```

□ What This Module Supports

- □ Curriculum mapping by module and duration
- □ Competency tracking with certification status
- □ Integration with logigram/algorigram logic for automation
- □ Extendable for learner progress dashboards or audit sheets

Would you like this module extended to include Visual Basic-based logigram execution or printable audit reports for each competency?

Copilot said

Based on your detailed curriculum framework, here is a Visual Basic module that automates skill tracking and certification for NSQF Level 5 Electrician Trade. This module is designed to support:

- □ Curriculum mapping by module and competency
- □ Certification status tracking
- □ Integration with logigram/algorigram logic
- □ Audit-ready reporting

□ Visual Basic Code - NSQF Level 5 Electrician Skill Tracker

```

vb
' Module: NSQF_ElectricianSkillTracker
' Purpose: Track competencies, modules, and certification status for NSQF
Level 5 Electrician Trade

Option Explicit

' Define structures
Type TradeModule
    ModuleID As Integer
    Title As String
    DurationWeeks As Integer
    FocusArea As String
End Type

Type CompetencyRecord
    Code As String
    Description As String

```

```

        LinkedModuleID As Integer
        Certified As Boolean
End Type

Dim Modules(1 To 6) As TradeModule
Dim Competencies(1 To 10) As CompetencyRecord

' Initialize modules
Sub InitializeModules()
    Modules(1) = CreateModule(1, "Safety & Hand Tools", 3, "Workshop safety, PPE, BIS tools")
    Modules(2) = CreateModule(2, "Workshop Practice", 4, "Fitting, carpentry, sheet metal")
    Modules(3) = CreateModule(3, "Wires & U.G. Cables", 5, "Crimping, soldering, cable testing")
    Modules(4) = CreateModule(4, "Basic Electrical Practice", 3, "Ohm's Law, circuits, resistance")
    Modules(5) = CreateModule(5, "Magnetism & Capacitors", 2, "EMF, inductance, capacitance")
    Modules(6) = CreateModule(6, "AC Circuits", 4, "AC theory, power factor, 3-phase systems")
End Sub

' Initialize competencies
Sub InitializeCompetencies()
    Competencies(1) = CreateCompetency("7411.0100", "Electrician General – Installation & Maintenance", 3, False)
    Competencies(2) = CreateCompetency("7412.0200", "Electrical Fitter – Assembly & Testing", 2, False)
    Competencies(3) = CreateCompetency("NSQF5.01", "Safety Compliance & PPE Usage", 1, False)
    Competencies(4) = CreateCompetency("NSQF5.02", "Cable Jointing & Fault Diagnosis", 3, False)
    Competencies(5) = CreateCompetency("NSQF5.03", "Circuit Analysis & Measurement", 4, False)
    Competencies(6) = CreateCompetency("NSQF5.04", "Magnetic & Capacitive Systems", 5, False)
    Competencies(7) = CreateCompetency("NSQF5.05", "AC Power Systems & Load Balancing", 6, False)
    Competencies(8) = CreateCompetency("NSQF5.06", "Logigram & Algorigram Automation", 4, False)
    Competencies(9) = CreateCompetency("NSQF5.07", "Use of Certified Instruments", 4, False)
    Competencies(10) = CreateCompetency("NSQF5.08", "Project Planning & Execution", 6, False)
End Sub

' Constructors
Function CreateModule(ID As Integer, Title As String, Weeks As Integer, Focus As String) As TradeModule
    Dim m As TradeModule
    m.ModuleID = ID
    m.Title = Title
    m.DurationWeeks = Weeks
    m.FocusArea = Focus

```

```

        CreateModule = m
End Function

Function CreateCompetency(Code As String, Desc As String, ModuleID As Integer, Certified As Boolean) As CompetencyRecord
    Dim c As CompetencyRecord
    c.Code = Code
    c.Description = Desc
    c.LinkedModuleID = ModuleID
    c.Certified = Certified
    CreateCompetency = c
End Function

' Display modules
Sub ShowModules()
    Dim i As Integer
    Debug.Print "□ NSQF Level 5 Electrician Modules"
    Debug.Print "ID", "Title", "Weeks", "Focus Area"
    For i = 1 To 6
        With Modules(i)
            Debug.Print .ModuleID, .Title, .DurationWeeks, .FocusArea
        End With
    Next i
End Sub

' Display competencies
Sub ShowCompetencies()
    Dim i As Integer
    Debug.Print "□ Competency Mapping & Certification Status"
    Debug.Print "Code", "Description", "Module", "Certified"
    For i = 1 To 10
        With Competencies(i)
            Debug.Print .Code, .Description, Modules(.LinkedModuleID).Title,
            IIf(.Certified, "Yes", "No")
        End With
    Next i
End Sub

' Mark competency as certified
Sub Certify(Code As String)
    Dim i As Integer
    For i = 1 To 10
        If Competencies(i).Code = Code Then
            Competencies(i).Certified = True
            Debug.Print "□ Competency " & Code & " marked as certified."
            Exit Sub
        End If
    Next i
    Debug.Print "□ Competency code not found."
End Sub

□

```

□ Visual Basic Code - SAQA NQF Level 3 Electrical Qualification Tracker

vb

```
' Module: SAQA_ElectricalQualificationTracker
' Purpose: Track learner progress across unit standards, credits, and
certification for SAQA Qualification ID 72051

Option Explicit

' Define structures
Type UnitStandard
    ID As String
    Title As String
    Level As Integer
    Credits As Integer
    Certified As Boolean
End Type

Dim MiningSpecialisation(1 To 12) As UnitStandard

' Initialize mining specialisation unit standards
Sub InitializeMiningSpecialisation()
    MiningSpecialisation(1) = CreateUnit("259037", "Design and Install
Electrical Wire Ways", 3, 8, False)
    MiningSpecialisation(2) = CreateUnit("258924", "Fault Find, Test and
Repair Domestic Appliances", 3, 6, False)
    MiningSpecialisation(3) = CreateUnit("113875", "Inspect, Operate and
Maintain High Mast Lighting Structures", 3, 7, False)
    MiningSpecialisation(4) = CreateUnit("258958", "Install/Replace Mini
Substations and Ring-Main Units/Switches", 3, 6, False)
    MiningSpecialisation(5) = CreateUnit("258997", "Install Batteries", 3, 4,
False)
    MiningSpecialisation(6) = CreateUnit("114660", "Install or Replace Medium
Voltage Transformers", 3, 6, False)
    MiningSpecialisation(7) = CreateUnit("259058", "Perform Work on Energised
Low Voltage Networks", 3, 8, False)
    MiningSpecialisation(8) = CreateUnit("113900", "Operate on MV Radial
Networks", 3, 20, False)
    MiningSpecialisation(9) = CreateUnit("258969", "Construct, Maintain and
Dismantle MV Overhead Lines", 3, 14, False)
    MiningSpecialisation(10) = CreateUnit("259117", "Maintain Electrical Mini
Substations", 3, 3, False)
    MiningSpecialisation(11) = CreateUnit("259097", "Inspect and Repair
Explosion Prevention Apparatus", 3, 6, False)
    MiningSpecialisation(12) = CreateUnit("262924", "Use and Care for MV
Electrical Test Instruments", 3, 4, False)
End Sub

' Constructor
Function CreateUnit(ID As String, Title As String, Level As Integer, Credits
As Integer, Certified As Boolean) As UnitStandard
    Dim u As UnitStandard
    u.ID = ID
```

```

        u.Title = Title
        u.Level = Level
        u.Credits = Credits
        u.Certified = Certified
        CreateUnit = u
    End Function

' Display all unit standards
Sub DisplayUnitStandards()
    Dim i As Integer
    Debug.Print "□ SAQA Qualification ID 72051 – Mining Specialisation (ID 72071)"
    Debug.Print "Unit ID", "Title", "Level", "Credits", "Certified"
    For i = 1 To 12
        With MiningSpecialisation(i)
            Debug.Print .ID, .Title, .Level, .Credits, IIf(.Certified, "Yes", "No")
        End With
    Next i
End Sub

' Certify a unit standard
Sub CertifyUnit(ID As String)
    Dim i As Integer
    For i = 1 To 12
        If MiningSpecialisation(i).ID = ID Then
            MiningSpecialisation(i).Certified = True
            Debug.Print "□ Unit Standard " & ID & " marked as certified."
            Exit Sub
        End If
    Next i
    Debug.Print "□ Unit Standard ID not found."
End Sub

' Calculate total certified credits
Sub CalculateCertifiedCredits()
    Dim i As Integer, totalCredits As Integer
    For i = 1 To 12
        If MiningSpecialisation(i).Certified Then
            totalCredits = totalCredits + MiningSpecialisation(i).Credits
        End If
    Next i
    Debug.Print "□ Total Certified Credits: " & totalCredits & " / 133 required"
End Sub

```

□ What This Module Supports

- Tracks learner progress across 12 unit standards in the mining specialisation
- Certifies individual unit standards and calculates total credits earned
- Aligns with SAQA's NQF Level 3 requirements (minimum 133 credits)
- Can be extended to include core and fundamental components

Would you like me to expand this module to include the full qualification structure (core, fundamental, elective) or generate a logigram for installation and fault tracing tasks?

This updated qualification consolidates and replaces:

- ID 48475: National Certificate: Electrical Engineering (NQF Level 3, 127 credits)
- ID 13640: Chemical Electrical (NQF Level 3)

It introduces a broader, modular structure that supports articulation across industries such as mining, energy, manufacturing, and renewables. The qualification is structured into three components:

□ Qualification Structure

1. Core Component (83 credits)

These unit standards cover essential electrical competencies:

Unit Standard ID	Title	NQF Level	Credits
259078	Install and commission metering/control devices	2	8
10270	Construct basic electronic circuits	3	4
258966	Inspect/test single-phase domestic installation	3	10
259077	Install/commission DOL AC machines and control gear	3	10
259038	Maintain/repair DOL AC machines and control gear	3	8
258965	Maintain lighting systems	3	4
9530	Manage work time effectively	3	3
258959	Operate on Low Voltage networks	3	12
258961	Repair/maintain electric power tools	3	6
258977	Understand basic electronic theory/components	3	4
258968	Wire/commission domestic or commercial circuits	3	8

2. Fundamental Component (36 credits)

These unit standards ensure foundational communication and numeracy:

Unit Standard ID	Title	NQF Level	Credi ts
119472	Accommodate audience/context in oral/signed communication	3	5
9010	Use number bases, units, and error awareness	3	2
9013	Calculate shape/motion in 2D/3D contexts	3	4
119457	Interpret and use information from texts	3	5
9012	Solve problems using data/probabilities	3	5
119467	Use language in occupational learning programmes	3	5
7456	Use maths to monitor financial aspects	3	5
119465	Write/present/sign texts for various contexts	3	5

3. Elective Component (Minimum 14 credits)

Learners choose from over 50 unit standards across specialisations such as:

- Switchgear assembly
- Renewable energy
- Mining and MV networks
- Solar systems
- Entrepreneurial and costing skills

Examples include:

- ID 265005: Understand switchgear assembly (3 credits)
- ID 258918: Use electrical measuring instruments (4 credits)
- ID 259037: Design/install electrical wire ways (8 credits)
- ID 114660: Install MV transformers (6 credits)
- ID 113900: Operate on MV radial networks (20 credits)

□ Learning Programmes and Quality Assurance

This qualification is offered under multiple learning programme IDs (e.g., 72071 for Mining, 72081 for Renewable Energy), each aligned with a specific industry. Quality assurance is managed by SETAs such as EWSETA, MERSETA, CHIETA, and MQA under the OQSF framework.

Would you like a Visual Basic module that tracks learner progress across these unit standards and calculates total credits toward certification?

.

□ Visual Basic Code - SAQA Qualification Tracker (ID 72051)

```

vb
' Module: SAQA_QualificationTracker
' Purpose: Track learner progress across unit standards for SAQA
Qualification ID 72051 (NQF Level 3, 133 credits)

Option Explicit

' Define structure
Type UnitStandard
    ID As String
    Title As String
    Component As String ' Core, Fundamental, Elective
    NQFLevel As Integer
    Credits As Integer
    Certified As Boolean
End Type

Dim Standards() As UnitStandard

' Initialize unit standards
Sub InitializeStandards()
    Dim i As Integer
    ReDim Standards(1 To 50) ' Adjust size as needed

    i = 1
    Standards(i) = CreateUnit("259078", "Install and commission
metering/control devices", "Core", 2, 8, False): i = i + 1
    Standards(i) = CreateUnit("10270", "Construct Basic Electronic Circuits",
"Core", 3, 4, False): i = i + 1
    Standards(i) = CreateUnit("258966", "Inspect and test single phase
domestic installation", "Core", 3, 10, False): i = i + 1
    Standards(i) = CreateUnit("259077", "Install DOL AC machines and control
gear", "Core", 3, 10, False): i = i + 1
    Standards(i) = CreateUnit("259038", "Maintain DOL AC machines and control
gear", "Core", 3, 8, False): i = i + 1
    Standards(i) = CreateUnit("258965", "Maintain lighting systems", "Core",
3, 4, False): i = i + 1
    Standards(i) = CreateUnit("9530", "Manage work time effectively", "Core",
3, 3, False): i = i + 1
    Standards(i) = CreateUnit("258959", "Operate on Low Voltage networks",
"Core", 3, 12, False): i = i + 1
    Standards(i) = CreateUnit("258961", "Repair and maintain electric power
tools", "Core", 3, 6, False): i = i + 1
    Standards(i) = CreateUnit("258977", "Understand basic electronic theory",
"Core", 3, 4, False): i = i + 1
    Standards(i) = CreateUnit("258968", "Wire and commission electrical
circuits", "Core", 3, 8, False): i = i + 1

    Standards(i) = CreateUnit("119472", "Oral/signed communication",
"Fundamental", 3, 5, False): i = i + 1
    Standards(i) = CreateUnit("9010", "Number bases and measurement units",
"Fundamental", 3, 2, False): i = i + 1
    Standards(i) = CreateUnit("9013", "Shape and motion in space",
"Fundamental", 3, 4, False): i = i + 1

```

```

Standards(i) = CreateUnit("119457", "Interpret and use texts",
"Fundamental", 3, 5, False): i = i + 1
Standards(i) = CreateUnit("9012", "Data and probabilities",
"Fundamental", 3, 5, False): i = i + 1
Standards(i) = CreateUnit("119467", "Language in occupational learning",
"Fundamental", 3, 5, False): i = i + 1
Standards(i) = CreateUnit("7456", "Maths for financial aspects",
"Fundamental", 3, 5, False): i = i + 1
Standards(i) = CreateUnit("119465", "Write/present/sign texts",
"Fundamental", 3, 5, False): i = i + 1

Standards(i) = CreateUnit("265005", "Switchgear assembly understanding",
"Elective", 2, 3, False): i = i + 1
Standards(i) = CreateUnit("258918", "Use electrical measuring
instruments", "Elective", 2, 4, False): i = i + 1
Standards(i) = CreateUnit("264997", "Assemble switchgear", "Elective", 3,
12, False): i = i + 1
Standards(i) = CreateUnit("259037", "Design and install wire ways",
"Elective", 3, 8, False): i = i + 1
Standards(i) = CreateUnit("258924", "Repair domestic appliances",
"Elective", 3, 6, False): i = i + 1
Standards(i) = CreateUnit("114660", "Install MV transformers",
"Elective", 3, 6, False): i = i + 1
Standards(i) = CreateUnit("259117", "Maintain mini substations",
"Elective", 3, 3, False): i = i + 1
End Sub

' Constructor
Function CreateUnit(ID As String, Title As String, Component As String, Level
As Integer, Credits As Integer, Certified As Boolean) As UnitStandard
    Dim u As UnitStandard
    u.ID = ID
    u.Title = Title
    u.Component = Component
    u.NQFLevel = Level
    u.Credits = Credits
    u.Certified = Certified
    CreateUnit = u
End Function

' Display all unit standards
Sub DisplayStandards()
    Dim i As Integer
    Debug.Print "□ SAQA Qualification Tracker – ID 72051"
    Debug.Print "ID", "Title", "Component", "Level", "Credits", "Certified"
    For i = LBound(Standards) To UBound(Standards)
        With Standards(i)
            Debug.Print .ID, .Title, .Component, .NQFLevel, .Credits,
            IIf(.Certified, "Yes", "No")
        End With
    Next i
End Sub

' Certify a unit standard
Sub CertifyUnit(ID As String)

```

```

Dim i As Integer
For i = LBound(Standards) To UBound(Standards)
    If Standards(i).ID = ID Then
        Standards(i).Certified = True
        Debug.Print "Unit " & ID & " marked as certified."
        Exit Sub
    End If
Next i
Debug.Print "Unit ID not found."
End Sub

' Calculate total certified credits
Sub CalculateCredits()
    Dim i As Integer, totalCore As Integer, totalFund As Integer,
    totalElective As Integer
    For i = LBound(Standards) To UBound(Standards)
        If Standards(i).Certified Then
            Select Case Standards(i).Component
                Case "Core": totalCore = totalCore + Standards(i).Credits
                Case "Fundamental": totalFund = totalFund +
Standards(i).Credits
                Case "Elective": totalElective = totalElective +
Standards(i).Credits
            End Select
        End If
    Next i
    Debug.Print "Certified Credits:"
    Debug.Print "Core: " & totalCore & " / 83"
    Debug.Print "Fundamental: " & totalFund & " / 36"
    Debug.Print "Elective: " & totalElective & " / 14 (minimum)"
    Debug.Print "Total: " & totalCore + totalFund + totalElective & " / 133
required"
End Sub

```

□ What This Module Supports

- Tracks certification status across all components
- Calculates total credits earned toward the 133-credit requirement
- Can be expanded to include additional unit standards or learning programmes
- Ideal for audit sheets, learner dashboards, and modular curriculum planning

Would you like me to extend this module to include exportable reports or integrate logigram-based task automation for installation and fault tracing?

□ Visual Basic Code - SAQA Qualification Tracker (ID 72052)

```

vb
' Module: SAQA_QualificationTracker_Level4
' Purpose: Track learner progress across unit standards for SAQA
Qualification ID 72052 (NQF Level 4, 130 credits)

```

Option Explicit

```
' Define structure
Type UnitStandard
    ID As String
    Title As String
    Component As String ' Core, Fundamental, Elective
    NQFLevel As Integer
    Credits As Integer
    Certified As Boolean
End Type

Dim Standards() As UnitStandard

' Initialize unit standards
Sub InitializeStandards()
    Dim i As Integer
    ReDim Standards(1 To 40) ' Adjust size as needed

    i = 1
    ' Core
    Standards(i) = CreateUnit("113899", "Basic programmable logic
controllers", "Core", 3, 6, False): i = i + 1
    Standards(i) = CreateUnit("259200", "Design and commission 3-phase
circuits", "Core", 4, 10, False): i = i + 1
    Standards(i) = CreateUnit("259217", "Install AC machines and control
gear", "Core", 4, 8, False): i = i + 1
    Standards(i) = CreateUnit("259177", "Maintain AC machines and control
gear", "Core", 4, 12, False): i = i + 1
    Standards(i) = CreateUnit("259197", "Test 3-phase installations", "Core",
4, 10, False): i = i + 1
    Standards(i) = CreateUnit("113873", "Basic electrical/mechanical
principles", "Core", 4, 8, False): i = i + 1

    ' Fundamental
    Standards(i) = CreateUnit("119472", "Oral/signed communication",
"Fundamental", 3, 5, False): i = i + 1
    Standards(i) = CreateUnit("119457", "Interpret texts", "Fundamental", 3,
5, False): i = i + 1
    Standards(i) = CreateUnit("119467", "Language in occupational learning",
"Fundamental", 3, 5, False): i = i + 1
    Standards(i) = CreateUnit("119465", "Write/present/sign texts",
"Fundamental", 3, 5, False): i = i + 1
    Standards(i) = CreateUnit("9015", "Statistics and probability",
"Fundamental", 4, 6, False): i = i + 1
    Standards(i) = CreateUnit("119462", "Evaluate spoken/signed texts",
"Fundamental", 4, 5, False): i = i + 1
    Standards(i) = CreateUnit("119469", "Analyse/respond to texts",
"Fundamental", 4, 5, False): i = i + 1
    Standards(i) = CreateUnit("9016", "Shape and motion in space",
"Fundamental", 4, 4, False): i = i + 1
    Standards(i) = CreateUnit("119471", "Language in occupational learning",
"Fundamental", 4, 5, False): i = i + 1
```

```

Standards(i) = CreateUnit("7468", "Maths for financial aspects",
"Fundamental", 4, 6, False): i = i + 1
Standards(i) = CreateUnit("119459", "Write/present/sign for wide
contexts", "Fundamental", 4, 5, False): i = i + 1

' Elective (sample)
Standards(i) = CreateUnit("264997", "Assemble switchgear", "Elective", 3,
12, False): i = i + 1
Standards(i) = CreateUnit("265007", "Legislation for switchgear",
"Elective", 3, 3, False): i = i + 1
Standards(i) = CreateUnit("265034", "Switchgear components/drawings",
"Elective", 3, 8, False): i = i + 1
Standards(i) = CreateUnit("259237", "Work on MV networks", "Elective", 4,
16, False): i = i + 1
Standards(i) = CreateUnit("259184", "HV overhead networks", "Elective",
4, 20, False): i = i + 1
Standards(i) = CreateUnit("113898", "Certificate of compliance",
"Elective", 4, 5, False): i = i + 1
Standards(i) = CreateUnit("116434", "Control electrical networks",
"Elective", 4, 10, False): i = i + 1
End Sub

' Constructor
Function CreateUnit(ID As String, Title As String, Component As String, Level
As Integer, Credits As Integer, Certified As Boolean) As UnitStandard
    Dim u As UnitStandard
    u.ID = ID
    u.Title = Title
    u.Component = Component
    u.NQFLevel = Level
    u.Credits = Credits
    u.Certified = Certified
    CreateUnit = u
End Function

' Display all unit standards
Sub DisplayStandards()
    Dim i As Integer
    Debug.Print "□ SAQA Qualification Tracker – ID 72052"
    Debug.Print "ID", "Title", "Component", "Level", "Credits", "Certified"
    For i = LBound(Standards) To UBound(Standards)
        With Standards(i)
            Debug.Print .ID, .Title, .Component, .NQFLevel, .Credits,
IIf(.Certified, "Yes", "No")
        End With
    Next i
End Sub

' Certify a unit standard
Sub CertifyUnit(ID As String)
    Dim i As Integer
    For i = LBound(Standards) To UBound(Standards)
        If Standards(i).ID = ID Then
            Standards(i).Certified = True
            Debug.Print "□ Unit " & ID & " marked as certified."
        End If
    Next i
End Sub

```

```

        Exit Sub
    End If
Next i
Debug.Print "□ Unit ID not found."
End Sub

' Calculate total certified credits
Sub CalculateCredits()
    Dim i As Integer, totalCore As Integer, totalFund As Integer,
    totalElective As Integer
    For i = LBound(Standards) To UBound(Standards)
        If Standards(i).Certified Then
            Select Case Standards(i).Component
                Case "Core": totalCore = totalCore + Standards(i).Credits
                Case "Fundamental": totalFund = totalFund +
Standards(i).Credits
                Case "Elective": totalElective = totalElective +
Standards(i).Credits
            End Select
        End If
    Next i
    Debug.Print "□ Certified Credits:"
    Debug.Print "Core: " & totalCore & " / ~54"
    Debug.Print "Fundamental: " & totalFund & " / ~46"
    Debug.Print "Elective: " & totalElective & " / ~30 (minimum)"
    Debug.Print "Total: " & totalCore + totalFund + totalElective & " / 130
required"
End Sub

```

□ What This Module Supports

- Tracks certification status across all components
- Calculates total credits earned toward the 130-credit requirement
- Modular and expandable for additional unit standards or specialisations
- Ideal for audit sheets, learner dashboards, and curriculum planning

Would you like me to extend this module to include exportable audit sheets or integrate logigram-based automation for installation and fault tracing tasks?

:

- □ Logging of workplace tasks (WE1-WE7)
- □ Verification of skill elements (WA codes)
- □ Progress tracking toward diploma completion
- □ Audit-ready reporting for supervisors and learners

□ Visual Basic Code - N Diploma Work Experience Tracker (ID 90674)


```

vb
' Module: N_Diploma_WorkExperienceTracker
' Purpose: Track learner progress across work experience components for SAQA
Qualification ID 90674

Option Explicit

' Define structures
Type WorkExperience
    Code As String
    Title As String
    Completed As Boolean
    DateCompleted As String
    SupervisorSignature As String
End Type

Type SkillEvidence
    Code As String
    Description As String
    LinkedWECode As String
    Verified As Boolean
End Type

Dim WE(1 To 7) As WorkExperience
Dim WA() As SkillEvidence

' Initialize work experience components
Sub InitializeWorkExperience()
    WE(1) = CreateWE("WE1", "Manual soldering/desoldering", False, "", "")
    WE(2) = CreateWE("WE2", "Interpret technical drawing", False, "", "")
    WE(3) = CreateWE("WE3", "Terminate and connect electrical wiring", False,
    "", "")
    WE(4) = CreateWE("WE4", "Install and test wiring/circuits up to 1000V
AC / 1500V DC", False, "", "")
    WE(5) = CreateWE("WE5", "Enter and change PLC operational parameters",
False, "", "")
    WE(6) = CreateWE("WE6", "Terminate and connect specialist cables", False,
    "", "")
    WE(7) = CreateWE("WE7", "Perform electrical/electronic measurement",
False, "", "")
End Sub

' Initialize skill evidence items
Sub InitializeSkillEvidence()
    Dim i As Integer
    ReDim WA(1 To 50) ' Expandable

    i = 1
    WA(i) = CreateWA("WA0101", "Performing routine soldering", "WE1", False):
i = i + 1
    WA(i) = CreateWA("WA0102", "Performing desoldering", "WE1", False): i = i
+ 1
    WA(i) = CreateWA("WA0201", "Checking drawing against job requirements",
"WE2", False): i = i + 1

```

```

    WA(i) = CreateWA("WA0301", "Checking materials for conformance", "WE3",
False): i = i + 1
    WA(i) = CreateWA("WA0401", "Interpreting circuits and specifications",
"WE4", False): i = i + 1
    WA(i) = CreateWA("WA0501", "Selecting data transfer device", "WE5",
False): i = i + 1
    WA(i) = CreateWA("WA0601", "Checking specialist cables", "WE6", False): i
= i + 1
    WA(i) = CreateWA("WA0701", "Setting and using measuring devices", "WE7",
False): i = i + 1
End Sub

```

```

' Constructors
Function CreateWE(Code As String, Title As String, Completed As Boolean,
DateCompleted As String, Signature As String) As WorkExperience
    Dim weItem As WorkExperience
    weItem.Code = Code
    weItem.Title = Title
    weItem.Completed = Completed
    weItem.DateCompleted = DateCompleted
    weItem.SupervisorSignature = Signature
    CreateWE = weItem
End Function

```

```

Function CreateWA(Code As String, Desc As String, LinkedWE As String,
Verified As Boolean) As SkillEvidence
    Dim waItem As SkillEvidence
    waItem.Code = Code
    waItem.Description = Desc
    waItem.LinkedWECode = LinkedWE
    waItem.Verified = Verified
    CreateWA = waItem
End Function

```

```

' Display work experience status
Sub DisplayWorkExperience()
    Dim i As Integer
    Debug.Print "□ Work Experience Tracker – SAQA ID 90674"
    Debug.Print "Code", "Title", "Completed", "Date", "Supervisor"
    For i = 1 To 7
        With WE(i)
            Debug.Print .Code, .Title, IIf(.Completed, "Yes",
"No"), .DateCompleted, .SupervisorSignature
        End With
    Next i
End Sub

```

```

' Display skill evidence status
Sub DisplaySkillEvidence()
    Dim i As Integer
    Debug.Print "□ Skill Evidence Verification"
    Debug.Print "Code", "Description", "Linked WE", "Verified"
    For i = LBound(WA) To UBound(WA)
        With WA(i)

```

```

        Debug.Print .Code, .Description, .LinkedWECode, IIf(.Verified,
"Yes", "No")
    End With
Next i
End Sub

' Mark work experience as completed
Sub CompleteWE(Code As String, CompletionDate As String, Supervisor As
String)
    Dim i As Integer
    For i = 1 To 7
        If WE(i).Code = Code Then
            WE(i).Completed = True
            WE(i).DateCompleted = CompletionDate
            WE(i).SupervisorSignature = Supervisor
            Debug.Print " " & Code & " marked completed by " & Supervisor
            Exit Sub
        End If
    Next i
    Debug.Print " Work Experience code not found."
End Sub

' Verify skill evidence
Sub VerifySkill(Code As String)
    Dim i As Integer
    For i = LBound(WA) To UBound(WA)
        If WA(i).Code = Code Then
            WA(i).Verified = True
            Debug.Print " Skill " & Code & " verified."
            Exit Sub
        End If
    Next i
    Debug.Print " Skill code not found."
End Sub

```

□

.

□ Overview and Scope

- **Qualification Title:** National N Diploma: Engineering Studies – Electrical Engineering
- **SAQA ID:** 90674
- **NQF Level:** 6
- **Credits:** 360
- **Instructional Programme Code:** 50908401
- **Learning Programme ID:** 67043

This diploma is designed for learners who have completed theoretical subjects and gained practical experience in one or more of 12 recognised

trades, including Electrician, Millwright, Instrument Technician, and Armature Winder. Learners must complete at least 10 work experience activities aligned to their area of specialisation.

□ Statement and Methodology

- **Workplace Evidence:** Learners must demonstrate competence in tasks such as soldering, wiring, PLC programming, and circuit testing.
- **Trade Alignment:** Activities are mapped to OFO codes and include specialisations in construction, high voltage, substations, refrigeration, electronics, and mechatronics.
- **Assessment Method:** Each work experience (WE) task includes a set of skill elements (WA codes) that must be verified by a supervisor.

□ Visual Basic Code - Work Experience Tracker

This module tracks completion of 7 core workplace tasks (WE1-WE7) and verifies associated skill elements (WA codes).

```
vb
' Work Experience Tracker for SAQA ID 90674
Type WorkExperience
    Code As String
    Title As String
    Completed As Boolean
    DateCompleted As String
    SupervisorSignature As String
End Type

Type SkillEvidence
    Code As String
    Description As String
    LinkedWECode As String
    Verified As Boolean
End Type

Dim WE(1 To 7) As WorkExperience
Dim WA() As SkillEvidence

Sub InitializeWorkExperience()
    WE(1) = CreateWE("WE1", "Manual soldering/desoldering", False, "", "")
    WE(2) = CreateWE("WE2", "Interpret technical drawing", False, "", "")
    WE(3) = CreateWE("WE3", "Terminate and connect wiring", False, "", "")
    WE(4) = CreateWE("WE4", "Install/test wiring up to 1000V AC / 1500V DC",
False, "", "")
    WE(5) = CreateWE("WE5", "Change PLC operational parameters", False, "",
    "")
    WE(6) = CreateWE("WE6", "Terminate specialist cables", False, "", "")
```

```

    WE(7) = CreateWE("WE7", "Perform electrical/electronic measurement",
False, "", "")
End Sub

```

```

Function CreateWE(Code As String, Title As String, Completed As Boolean,
DateCompleted As String, Signature As String) As WorkExperience
    Dim weItem As WorkExperience
    weItem.Code = Code
    weItem.Title = Title
    weItem.Completed = Completed
    weItem.DateCompleted = DateCompleted
    weItem.SupervisorSignature = Signature
    CreateWE = weItem
End Function

```

```

Function CreateWA(Code As String, Desc As String, LinkedWE As String,
Verified As Boolean) As SkillEvidence
    Dim waItem As SkillEvidence
    waItem.Code = Code
    waItem.Description = Desc
    waItem.LinkedWECode = LinkedWE
    waItem.Verified = Verified
    CreateWA = waItem
End Function

```

```

Sub DisplayWorkExperience()
    Dim i As Integer
    Debug.Print "Work Experience Summary"
    For i = 1 To 7
        With WE(i)
            Debug.Print .Code, .Title, IIf(.Completed, "Yes",
"No"), .DateCompleted, .SupervisorSignature
        End With
    Next i
End Sub

```

```

Sub CompleteWE(Code As String, CompletionDate As String, Supervisor As
String)
    Dim i As Integer
    For i = 1 To 7
        If WE(i).Code = Code Then
            WE(i).Completed = True
            WE(i).DateCompleted = CompletionDate
            WE(i).SupervisorSignature = Supervisor
            Debug.Print "Completed: " & Code & " by " & Supervisor
            Exit Sub
        End If
    Next i
End Sub

```

Conclusion

This logbook framework ensures that learners in the National N Diploma programme gain verified, workplace-based experience aligned to their

theoretical studies. The Visual Basic module supports structured tracking, supervisor validation, and audit-ready reporting.

Would you like me to generate a printable logbook template or integrate this tracker with your

:

- ☐ Logging completion of each WE task
- ☐ Verifying individual WA skills
- ☐ Capturing supervisor signatures and dates
- ☐ Generating audit-ready summaries for diploma validation

☐ Visual Basic Code - Full Work Experience Tracker (WE1-WE15)

vb

```
' Module: N_Diploma_FullWorkExperienceTracker
' Purpose: Track learner progress across 15 work experience tasks and verify associated skills
```

```
Option Explicit
```

```
Type WorkExperience
    Code As String
    Title As String
    Completed As Boolean
    DateCompleted As String
    SupervisorSignature As String
End Type
```

```
Type SkillEvidence
    Code As String
    Description As String
    LinkedWECode As String
    Verified As Boolean
End Type
```

```
Dim WE(1 To 15) As WorkExperience
Dim WA() As SkillEvidence
```

```
' Initialize WE tasks
Sub InitializeWorkExperience()
    WE(1) = CreateWE("WE1", "Manual soldering/desoldering")
    WE(2) = CreateWE("WE2", "Interpret technical drawing")
    WE(3) = CreateWE("WE3", "Terminate and connect electrical wiring")
    WE(4) = CreateWE("WE4", "Install/test wiring up to 1000V AC / 1500V DC")
    WE(5) = CreateWE("WE5", "Change PLC operational parameters")
    WE(6) = CreateWE("WE6", "Terminate and connect specialist cables")
    WE(7) = CreateWE("WE7", "Perform electrical/electronic measurement")
```

```

    WE(8) = CreateWE("WE8", "Perform precision electrical/electronic
measurement")
    WE(9) = CreateWE("WE9", "Perform engineering measurements")
    WE(10) = CreateWE("WE10", "Use power tools/hand held operations")
    WE(11) = CreateWE("WE11", "Fault find/repair equipment up to 250V single
phase")
    WE(12) = CreateWE("WE12", "Fault find/repair equipment up to 1000V AC /
1500V DC")
    WE(13) = CreateWE("WE13", "Diagnose and maintain electronic control
systems on mobile plant")
    WE(14) = CreateWE("WE14", "Fault find and repair basic electrical
circuits")
    WE(15) = CreateWE("WE15", "Disconnect/reconnect fixed wired equipment up
to 1000V AC / 1500V DC")
End Sub

' Constructor for WE
Function CreateWE(Code As String, Title As String) As WorkExperience
    Dim weItem As WorkExperience
    weItem.Code = Code
    weItem.Title = Title
    weItem.Completed = False
    weItem.DateCompleted = ""
    weItem.SupervisorSignature = ""
    CreateWE = weItem
End Function

' Constructor for WA
Function CreateWA(Code As String, Desc As String, LinkedWE As String) As
SkillEvidence
    Dim waItem As SkillEvidence
    waItem.Code = Code
    waItem.Description = Desc
    waItem.LinkedWECode = LinkedWE
    waItem.Verified = False
    CreateWA = waItem
End Function

' Sample WA initialization (expandable)
Sub InitializeSkillEvidence()
    ReDim WA(1 To 10) ' Expand to full list as needed
    WA(1) = CreateWA("WA0601", "Check cables/materials for condition and
specs", "WE6")
    WA(2) = CreateWA("WA0602", "Interpret appropriate documentation", "WE6")
    WA(3) = CreateWA("WA0603", "Make terminations to spec", "WE6")
    WA(4) = CreateWA("WA0701", "Set and use electro-measuring devices",
"WE7")
    WA(5) = CreateWA("WA0702", "Interpret electrical measurements", "WE7")
    WA(6) = CreateWA("WA0801", "Interpret drawings/specs/data sheets", "WE8")
    WA(7) = CreateWA("WA0901", "Select appropriate measuring device", "WE9")
    WA(8) = CreateWA("WA1001", "Read and follow SOPs", "WE10")
    WA(9) = CreateWA("WA1101", "Obtain circuit diagrams/specs", "WE11")
    WA(10) = CreateWA("WA1201", "Use diagnostic skills", "WE12")
End Sub

```

```

' Display WE summary
Sub DisplayWorkExperience()
    Dim i As Integer
    Debug.Print "□ Work Experience Summary – SAQA ID 90674"
    Debug.Print "Code", "Title", "Completed", "Date", "Supervisor"
    For i = 1 To 15
        With WE(i)
            Debug.Print .Code, .Title, IIf(.Completed, "Yes",
"No"), .DateCompleted, .SupervisorSignature
        End With
    Next i
End Sub

' Display WA verification status
Sub DisplaySkillEvidence()
    Dim i As Integer
    Debug.Print "□ Skill Evidence Verification"
    Debug.Print "Code", "Description", "Linked WE", "Verified"
    For i = LBound(WA) To UBound(WA)
        With WA(i)
            Debug.Print .Code, .Description, .LinkedWECode, IIf(.Verified,
"Yes", "No")
        End With
    Next i
End Sub

' Mark WE as completed
Sub CompleteWE(Code As String, CompletionDate As String, Supervisor As
String)
    Dim i As Integer
    For i = 1 To 15
        If WE(i).Code = Code Then
            WE(i).Completed = True
            WE(i).DateCompleted = CompletionDate
            WE(i).SupervisorSignature = Supervisor
            Debug.Print "□ " & Code & " marked completed by " & Supervisor
            Exit Sub
        End If
    Next i
End Sub

' Verify WA skill
Sub VerifySkill(Code As String)
    Dim i As Integer
    For i = LBound(WA) To UBound(WA)
        If WA(i).Code = Code Then
            WA(i).Verified = True
            Debug.Print "□ Skill " & Code & " verified."
            Exit Sub
        End If
    Next i
End Sub

:

```


- □ Logging completion of all 28 WE tasks
- □ Verifying over 250 WA skill elements
- □ Capturing supervisor signatures and dates
- □ Generating audit-ready summaries for diploma validation

□ Visual Basic Code - Extended Work Experience Tracker (WE1-WE28)

vb

```
' Module: N_Diploma_CompleteWorkExperienceTracker
' Purpose: Track learner progress across 28 work experience tasks and verify
associated WA skills
```

```
Option Explicit
```

```
Type WorkExperience
    Code As String
    Title As String
    Completed As Boolean
    DateCompleted As String
    SupervisorSignature As String
End Type
```

```
Type SkillEvidence
    Code As String
    Description As String
    LinkedWECode As String
    Verified As Boolean
End Type
```

```
Dim WE(1 To 28) As WorkExperience
Dim WA() As SkillEvidence
```

```
' Constructor for WE
Function CreateWE(Code As String, Title As String) As WorkExperience
    Dim weItem As WorkExperience
    weItem.Code = Code
    weItem.Title = Title
    weItem.Completed = False
    weItem.DateCompleted = ""
    weItem.SupervisorSignature = ""
    CreateWE = weItem
End Function
```

```
' Constructor for WA
Function CreateWA(Code As String, Desc As String, LinkedWE As String) As
SkillEvidence
    Dim waItem As SkillEvidence
    waItem.Code = Code
    waItem.Description = Desc
    waItem.LinkedWECode = LinkedWE
    waItem.Verified = False
    CreateWA = waItem
```

End Function

```
' Initialize new WE tasks (WE23–WE28)
Sub InitializeAdditionalWorkExperience()
    WE(23) = CreateWE("WE23", "Maintain/repair control instrumentation –
single/multiple loop systems")
    WE(24) = CreateWE("WE24", "Install, maintain and calibrate
instrumentation sensors/transmitters/final control elements")
    WE(25) = CreateWE("WE25", "Terminate signal and data cables")
    WE(26) = CreateWE("WE26", "Maintain instrumentation system components")
    WE(27) = CreateWE("WE27", "Diagnose and repair digital
equipment/components")
    WE(28) = CreateWE("WE28", "Apply OH&S principles in the work
environment")
End Sub

' Sample WA initialization for WE23–WE28 (expandable)
Sub InitializeAdditionalSkillEvidence()
    ReDim Preserve WA(1 To 30) ' Expand as needed

    WA(21) = CreateWA("WA2301", "Interpret engineering specs and operational
data", "WE23")
    WA(22) = CreateWA("WA2401", "Access data sheets and supplier catalogues",
"WE24")
    WA(23) = CreateWA("WA2501", "Identify signal/data cables and conductors",
"WE25")
    WA(24) = CreateWA("WA2601", "Obtain operational data for instrumentation
systems", "WE26")
    WA(25) = CreateWA("WA2701", "Obtain circuit diagrams and maintenance
records", "WE27")
    WA(26) = CreateWA("WA2801", "Follow safe working practices", "WE28")
    WA(27) = CreateWA("WA2805", "Use appropriate safety equipment/devices",
"WE28")
    WA(28) = CreateWA("WA2809", "Note workplace hazards", "WE28")
    WA(29) = CreateWA("WA2811", "Follow emergency/evacuation procedures",
"WE28")
    WA(30) = CreateWA("WA2815", "Check for conformance to OH&S
specifications", "WE28")
End Sub

' Display WE summary
Sub DisplayWorkExperience()
    Dim i As Integer
    Debug.Print "□ Work Experience Summary – SAQA ID 90674"
    Debug.Print "Code", "Title", "Completed", "Date", "Supervisor"
    For i = 1 To 28
        With WE(i)
            Debug.Print .Code, .Title, IIf(.Completed, "Yes",
"No"), .DateCompleted, .SupervisorSignature
        End With
    Next i
End Sub

' Display WA verification status
Sub DisplaySkillEvidence()
```

```

    Dim i As Integer
    Debug.Print "□ Skill Evidence Verification"
    Debug.Print "Code", "Description", "Linked WE", "Verified"
    For i = LBound(WA) To UBound(WA)
        With WA(i)
            Debug.Print .Code, .Description, .LinkedWECode, IIf(.Verified,
"Yes", "No")
        End With
    Next i
End Sub

' Mark WE as completed
Sub CompleteWE(Code As String, CompletionDate As String, Supervisor As
String)
    Dim i As Integer
    For i = 1 To 28
        If WE(i).Code = Code Then
            WE(i).Completed = True
            WE(i).DateCompleted = CompletionDate
            WE(i).SupervisorSignature = Supervisor
            Debug.Print "□ " & Code & " marked completed by " & Supervisor
            Exit Sub
        End If
    Next i
End Sub

' Verify WA skill
Sub VerifySkill(Code As String)
    Dim i As Integer
    For i = LBound(WA) To UBound(WA)
        If WA(i).Code = Code Then
            WA(i).Verified = True
            Debug.Print "□ Skill " & Code & " verified."
            Exit Sub
        End If
    Next i
End Sub

```

Would you like me to scaffold a printable logbook template or generate a Visual Basic-based dashboard to summarize learner progress across all 28 work experience tasks?

Copilot said

Here's a structured summary of the SAQA-registered doctoral qualification in Electrical Engineering, including its purpose, outcomes, and transition history:

□ SAQA Qualification Summary

Qualification Title: Doctor of Technology: Engineering: Electrical **SAQA Qualification ID:** 78780 **Originator:** Cape Peninsula University of Technology **NQF Level:** 10 (Doctoral) **Minimum Credits:** 240 **Sub-framework:** HEQSF – Higher Education Qualifications Sub-framework **Quality Assurance:** CHE – Council on Higher Education **Field:** Physical Planning and Construction **Subfield:** Electrical Infrastructure Construction **Registration Status:** Passed End Date **Last Enrolment:** 2015-12-31 **Last Achievement:** 2018-12-31

□ Qualification Transition

Status	SAQA ID	Title	NQF Level	Credits
Replaces	16091	Doctor of Technology: Engineering: Electrical	10	240
Replaced by	97019	Doctor of Engineering in Electrical Engineering	10	360

□ Purpose and Rationale

This doctoral qualification enables learners to:

- Conduct independent, original research in Electrical Engineering.
- Contribute to knowledge production through a dissertation aligned with doctoral norms.
- Apply advanced research methods, tools, and scientific reasoning.

□ Entry Requirements

- A completed Master's Degree in Electrical Engineering.
- No formal recognition of prior learning (RPL) for this qualification.

□ Qualification Rules

The qualification is awarded upon:

- Demonstrated achievement of specified outcomes.
- Evidence of competence through research, training, or experience.

□ Exit Level Outcomes

1. Demonstrate advanced knowledge and understanding of the research field.

2. Apply appropriate research methods and techniques.

☐ Specified Outcomes

- Understand the scope and depth of the chosen research area.
- Select and apply scientific methods and tools effectively.
- Produce a dissertation that reflects analytical rigor and methodological correctness.

☐ Assessment Criteria

- Literature review reflects familiarity with current trends, models, and theories.
- Research problem is clearly defined and hypothesis-driven.
- Data interpretation shows logical reasoning and ability to evaluate contradictions.
- Use of IT, statistical tools, and communication skills is accurate and effective.

☐ Articulation Options

- Doctorate in Applied Science or equivalent doctoral-level qualifications.

☐ Accredited Provider

- Cape Peninsula University of Technology

Would you like me to help map your current qualifications or research portfolio to the replacement qualification (Doctor of Engineering in Electrical Engineering, SAQA ID 97019)?

:

☐ Qualification Overview

Qualification Title: National Certificate: N2 Engineering Studies **SAQA Qualification ID:** 67375 **Originator:** SGB Engineering **NQF Level:** 2 **Minimum Credits:** 40 **Sub-framework:** GFETQSF – General and Further Education and Training Qualifications Sub-framework **Quality Assurance Functionary:** UMALUSI **Field:** Manufacturing, Engineering and Technology **Subfield:** Engineering and Related Design **Registration**

Status: Passed End Date **Last Enrolment:** 2024-06-30 **Last Achievement:** 2027-06-30

□ Purpose and Rationale

This part-qualification provides focused, workplace-related learning without requiring general academic subjects. It offers an alternative route for learners outside the formal schooling system to gain technical skills and become employable or self-sufficient.

□ Entry Requirements and RPL

Learning Assumed to Be in Place:

- National Certificate: N1 Engineering Studies
- Grade 10 with three applicable instructional offerings
- Equivalent qualification

Recognition of Prior Learning (RPL):

- May grant access to learners who don't meet entry requirements
- May award credits toward the part-qualification

□ Qualification Rules

To earn the certificate, learners must complete at least three instructional offerings, including:

- **Category A:** Trade Theory or Technological Offering (compulsory for apprentices)
- **Category B:** Mathematics
- **Category C:** Science
- **Category D:** Drawing

□ Instructional Offerings (Selected Examples)

Code	Title	Category
11041872	Electrical Trade Theory N2	A
16030192	Mathematics N2	B
150704	Engineering Science	C

Code	Title	Category
02	Theory N2	
8090272	Engineering Drawing N2 D	
8080602	Industrial Electronics N2 A	
11022082	Welders' Theory N2	A
11040012	Plant Operation Theory N2	A
5110002	Communication N2	—

There are over 70 instructional offerings across trades such as:

- Electrical, Diesel, Refrigeration, Instrumentation
- Aircraft, Radio, Plumbing, Welding, Carpentry
- Electronics, Electro-mechanics, Toolmaking, Upholstery

Would you like help mapping this N2 qualification to a current or replacement qualification for curriculum alignment or trade test preparation?

□ Qualification Overview

Qualification Title: National Certificate: N4 Engineering Studies **SAQA Qualification ID:** 66881 **Originator:** Department of Education **NQF Level:** 5 **Minimum Credits:** 40 **Sub-framework:** OQSF – Occupational Qualifications Sub-framework **Quality Assurance Functionary:** QCTO – Quality Council for Trades and Occupations **Field:** Manufacturing, Engineering and Technology **Subfield:** Engineering and Related Design **Registration Status:** Passed End Date **Last Enrolment:** 2026-06-30 **Last Achievement:** 2029-06-30

□ Qualification Transition

Status	SAQA ID	Title	NQF Level	Credits
Replaced by	122626	Occupational Diploma: Mechanical Engineering Technician (Automation)	6	417

□ Purpose and Rationale

This part-qualification provides learners with:

- Technical, theoretical, practical, and workplace knowledge in a chosen vocational area.
- A pathway to the National N Diploma when combined with N5 and N6 plus 18-24 months of practical experience.
- Entry-level employability and opportunities for upskilling or continuing education.

Rationale: Supports alternative education routes for learners exiting formal schooling, aligned with the Skills Summit Declaration (2010) promoting lifelong learning, employability, and enterprise development.

□ Entry Requirements and RPL

Learning Assumed to Be in Place:

- National Certificate: N3 Engineering Studies
- Senior Certificate with three relevant instructional offerings
- Equivalent qualification

Recognition of Prior Learning (RPL):

- May grant access to non-qualifying learners
- May award credits toward the part-qualification

□ Qualification Rules

To earn the certificate, learners must complete at least three instructional offerings. However, the following combinations are prohibited:

□ Radar Systems N4 + Radar Technology N4 □ Digital Electronics N4 + Logic Systems N4 □ Building and Structural Construction N4 + Mechanical Draughting N4 + Plating and Structural Steel Drawing N4

□ Instructional Offerings (Selected Examples)

Code	Title
08080074	ElectroTechnics N4
08080164	Industrial Electronics N4
08080194	Industrial Instruments N4

Code	Title
080802 84	Logic Systems N4
080803 54	Digital Electronics N4
080902 04	Mechanical Draughting N4
081900 04	Refrigeration, Air Conditioning and Ventilation N4
150704 34	Engineering Science N4
160301 64	Mathematics N4

There are over 40 instructional offerings across disciplines such as:

- Electronics, Instrumentation, Metallurgy
- Aircraft, Radar, Refrigeration
- Motor Vehicle Science, Chemistry, Mathematics
- Building, Structural Surveying, Production Control

□ **Exit Level Outcomes**

Defined per module in the curriculum statements. Learners are expected to demonstrate competence in technical knowledge, application, and workplace readiness.

□ **Articulation Options**

- Vertically articulates into National Certificate: N5 Engineering Studies.

Would you like help mapping this N4 qualification to the replacement Occupational Diploma (SAQA ID 122626) or aligning it with your current curriculum framework?

Copilot said

Here's a structured summary of the SAQA-registered qualification that has passed its end date, including its purpose, structure, and transition pathway:

□ **Qualification Overview**

Qualification Title: National Certificate: N4 Engineering Studies **SAQA Qualification ID:** 66881 **Originator:** Department of Education **NQF Level:** 5 **Minimum Credits:** 40 **Qualification Type:** National N Certificate **Sub-framework:** OQSF – Occupational Qualifications Sub-framework **Quality Assurance:** QCTO – Quality Council for Trades and Occupations **Field:** Manufacturing, Engineering and Technology **Subfield:** Engineering and Related Design **Registration Status:** Passed End Date

- Last Enrolment: 2026-06-30
- Last Achievement: 2029-06-30

□ Qualification Transition

Status	SAQA ID	Title	NQF Level	Credits
Replaced by	122626	Occupational Diploma: Mechanical Engineering Technician (Automation)	6	417

□ Purpose and Rationale

This part-qualification provides learners with:

- Technical, theoretical, and workplace knowledge in a chosen vocational area.
- A pathway to the National N Diploma when combined with N5 and N6 plus 18–24 months of practical experience.
- Entry-level employability and opportunities for upskilling or continuing education.

Rationale: Supports alternative education routes for learners exiting formal schooling, aligned with the Skills Summit Declaration (2010) promoting lifelong learning, employability, and enterprise development.

□ Entry Requirements and RPL

Learning Assumed to Be in Place:

- National Certificate: N3 Engineering Studies
- Senior Certificate with three relevant instructional offerings
- Equivalent qualification

Recognition of Prior Learning (RPL):

- May grant access to non-qualifying learners

- May award credits toward the part-qualification

□ **Qualification Rules**

To earn the certificate, learners must complete at least three instructional offerings. However, the following combinations are prohibited:

□ Radar Systems N4 + Radar Technology N4 □ Digital Electronics N4 + Logic Systems N4 □ Building and Structural Construction N4 + Mechanical Draughting N4 + Plating and Structural Steel Drawing N4

□ **Instructional Offerings (Selected Examples)**

Code	Title
080800 74	ElectroTechnics N4
080801 64	Industrial Electronics N4
080801 94	Industrial Instruments N4
080802 84	Logic Systems N4
080803 54	Digital Electronics N4
080902 04	Mechanical Draughting N4
081900 04	Refrigeration, Air Conditioning and Ventilation N4
150704 34	Engineering Science N4
160301 64	Mathematics N4

There are over 40 instructional offerings across disciplines such as:

- Electronics, Instrumentation, Metallurgy
- Aircraft, Radar, Refrigeration
- Motor Vehicle Science, Chemistry, Mathematics
- Building, Structural Surveying, Production Control

□ **Exit Level Outcomes**

Defined per module in the curriculum statements. Learners are expected to demonstrate competence in technical knowledge, application, and workplace readiness.

□ Articulation Options

- Vertically articulates into National Certificate: N5 Engineering Studies.

Would you like help mapping this N4 qualification to the replacement Occupational Diploma (SAQA ID 122626) or aligning it with your current curriculum framework?

:

□ Qualification Overview

Qualification Title: National Certificate: N3 Engineering Studies **SAQA Qualification ID:** 67491 **Originator:** SGB Engineering **NQF Level:** 3 **Minimum Credits:** 40 **Qualification Type:** National Certificate **Sub-framework:** GFETQSF – General and Further Education and Training Qualifications Sub-framework **Quality Assurance Functionary:** UMALUSI **Field:** Manufacturing, Engineering and Technology **Subfield:** Engineering and Related Design **Registration Status:** Passed End Date

- Last Enrolment: 2024-06-30
- Last Achievement: 2027-06-30

□ Purpose and Rationale

This part-qualification provides focused, workplace-related foundational learning without requiring general academic subjects. It offers an alternative route for learners outside the formal schooling system to gain technical skills and become employable or self-sufficient.

Rationale: Addresses high dropout rates, unemployment, and skills shortages by creating alternative education pathways for learners seeking vocational competence and formal recognition.

□ Entry Requirements and RPL

Learning Assumed to Be in Place:

- National Certificate: N2

- Grade 11 with three applicable instructional offerings
- Equivalent qualification

Recognition of Prior Learning (RPL):

- May grant access to learners who do not meet entry requirements
- May award credits toward the part-qualification

□ Qualification Rules

To earn the certificate, learners must complete at least three instructional offerings. Requirements differ for apprentices and non-apprentices:

Apprenticed Learners:

- Must include a Trade Theory or Technological offering (Category A)
- Plus three offerings from:
 - Mathematics (Category B)
 - Science (Category C)
 - Drawing (Category D)

Non-Apprenticed Learners:

- Any three offerings from:
 - Trade Theory or Technological (Category A)
 - Mathematics (Category B)
 - Science (Category C)
 - Drawing (Category D)
- Must submit a sworn statement confirming non-apprentice status

□ Instructional Offerings (Selected Examples)

Code	Title	Category
11041263	Electrical Trade Theory N3	A
16030143	Mathematics N3	B
15070413	Engineering Science N3	C
08090283	Engineering Drawing N3	D
11040673	Motor Trade Theory N3	A

Code	Title	Category
11040463	Instrument Trade Theory N3	A
11040843	Radio and Television Theory N3	A
08080613	Industrial Electronics N3	A

There are over 60 instructional offerings across trades such as:

- Electrical, Diesel, Refrigeration, Instrumentation
- Aircraft, Radio, Plumbing, Welding, Carpentry
- Electronics, Electro-mechanics, Toolmaking, Upholstery

Would you like help mapping this N3 qualification to a current or replacement qualification, or

:

□ Qualification Overview

Qualification Title: National Certificate: N6 Engineering Studies **SAQA Qualification ID:** 67005 **Originator:** Department of Education **NQF Level:** 5 **Minimum Credits:** 40 **Qualification Type:** National N Certificate **Sub-framework:** OQSF – Occupational Qualifications Sub-framework **Quality Assurance Functionary:** QCTO – Quality Council for Trades and Occupations **Field:** Manufacturing, Engineering and Technology **Subfield:** Engineering and Related Design **Registration Status:** Passed End Date

- Last Enrolment: 2026-06-30
- Last Achievement: 2029-06-30

□ Qualification Transition

Status	SAQA ID	Title	NQF Level	Credits
Replaced by	122626	Occupational Diploma: Mechanical Engineering Technician (Automation)	6	417

□ Purpose and Rationale

This part-qualification provides learners with:

- Technical, theoretical, and workplace knowledge in a chosen vocational area.
- A pathway to the National N Diploma when combined with N4 and N5 plus 18-24 months of practical experience.
- Entry-level employability and opportunities for upskilling or continuing education.

Rationale: Supports alternative education routes for learners exiting formal schooling, aligned with the Skills Summit Declaration (2010) promoting lifelong learning, employability, and enterprise development.

□ Entry Requirements and RPL

Learning Assumed to Be in Place:

- National Certificate: N5 Engineering Studies
- Equivalent qualification with applicable prerequisites

Recognition of Prior Learning (RPL):

- May grant access to non-qualifying learners
- May award credits toward the part-qualification

□ Qualification Rules

To earn the certificate, learners must complete at least three instructional offerings. These must align with the learner's occupational focus and may include:

□ Instructional Offerings (Selected Examples)

Code	Title
080800 16	Control Systems N6
080800 96	Electro-Technics N6
080801 86	Industrial Electronics N6
080802 16	Industrial Instruments N6
080803 06	Logic Systems N6
080803	Digital Electronics

Code	Title
76	N6
081902 16	Fluid Mechanics N6
081900 46	Power Machines N6
150701 26	Engineering Physics N6
160301 86	Mathematics N6

There are over 40 instructional offerings across disciplines such as:

- Electronics, Instrumentation, Control Systems
- Aircraft, Radar, Refrigeration
- Metallurgy, Fluid Mechanics, Chemical Technology
- Mathematics, Engineering Physics, Mechanical Design

□ **Exit Level Outcomes**

Defined per module in the curriculum statements. Learners are expected to demonstrate competence in technical knowledge, application, and workplace readiness.

□ **Articulation Options**

- Vertically articulates into the National N Diploma (with practical experience)
- Horizontally into other NQF Level 5 engineering qualifications

Would you like help mapping this N6 qualification to the replacement Occupational Diploma (SAQA ID 122626) or aligning it with your modular curriculum framework for trade test readiness?

□ **ICASS Semester Mark Structure**

Each student must complete **three assessment tasks per semester**. These tasks form the **ICASS semester mark**, which contributes to the final subject result.

□ **Assessment Task Breakdown**

Term	Assessment Tasks
Term 1	1 Test or 1 Assignment
Term 2	1 Test or 1 Assignment (with external moderation) 1 Internal Examination
Total	3 Tasks (Test + Assignment + Internal Exam)

□ ANNEXURE G1: Analysis Grid (for each test)

This grid must be completed and submitted for **pre-assessment moderation**.

Required Fields:

- **Subject & Level**
- **Lecturer**
- **Task**
- **Moderator**
- **Learning Objectives (LOs)** – numbered only
- **Question Breakdown:**
 - Question Number
 - Format/Type (Short, *Medium*, *Extended*^{**})
 - Duration (minutes)
 - Mark Allocation by Cognitive Level:
 - Knowledge
 - Application
 - Analysis & Problem Solving
- **Total Marks**
- **Signatures:** Lecturer and Moderator

□ Response Types and Cognitive Levels

Response Type	Description
*Short Response	Multiple-choice, one-word, definitions, lists
**Medium Response	Short explanations/descriptions (few sentences)
***Extended	Long explanations/descriptions (several sentences)
Cognitive Level	Focus

Response Type	Description
1. Knowledge	Recall, definitions, facts
2. Application	Use of concepts, calculations
3. Analysis/Problem Solving	Interpretation, evaluation, synthesis

□ ANNEXURE G2: Pre-Assessment Moderation Process

Key Steps:

Process	Responsibility	Timeline
Allocate examiners and moderators per subject/level	HOD / Senior Lecturer	Before classes begin
Ensure examiners and moderators are subject experts	HOD / Senior Lecturer	Before classes begin
Add internal college due dates to meet committee deadlines	HOD / Senior Lecturer	Before classes begin

□ *Note:* Examiner = Lecturer setting the task. Moderator = Peer reviewer. They must be different individuals.

Would you like a Visual Basic module or Excel template to automate the ANNEXURE G1 analysis grid for each test and link it to ICASS mark compilation?

Copilot said

Here is a professionally structured set of moderation tables for **ANNEXURE G2** and **ANNEXURE G3**, designed for use in Report 191 pre- and post-assessment processes. These can be adapted into a printable or digital form for moderation records and quality assurance.

□ ANNEXURE G2: Pre-Assessment Moderation Checklist

LECTURER:	MODERATOR:
_____ SUBJECT: _____	_____ ASSESSMENT TASK: _____

CRITERION 1: Analysis of Task

Criteria	Examine r	Moderat or
1.1 Name of subject, task, lecturer and moderator is provided	Yes/No/ N/A	Yes/No/ N/A
1.2 Subject aims/learning objectives are listed	Yes/No/ N/A	Yes/No/ N/A
1.3 Conceptual level indicated per question/instruction with mark allocation	Yes/No/ N/A	Yes/No/ N/A
1.4 Spread of conceptual weighting indicated for the task as a whole	Yes/No/ N/A	Yes/No/ N/A

CRITERION 2: Technical Criteria

Criteria	Examine r	Moderat or
2.1 Cover page includes subject, time, and mark allocation	Yes/No/ N/A	Yes/No/ N/A
2.2 Clear and unambiguous instructions	Yes/No/ N/A	Yes/No/ N/A
2.3 Reader-friendly layout	Yes/No/ N/A	Yes/No/ N/A
2.4 Correct question numbering	Yes/No/ N/A	Yes/No/ N/A
2.5 Pages numbered	Yes/No/ N/A	Yes/No/ N/A
2.6 Appropriate fonts used	Yes/No/ N/A	Yes/No/ N/A
2.7 Correct formatting (page breaks, spacing)	Yes/No/ N/A	Yes/No/ N/A
2.8 Clear mark allocation per question/subsection	Yes/No/ N/A	Yes/No/ N/A
2.9 Task fits within allocated time	Yes/No/ N/A	Yes/No/ N/A
2.10 Formula/Answer sheets/Addenda attached	Yes/No/ N/A	Yes/No/ N/A
2.11 Clear and complete drawings (with marks)	Yes/No/ N/A	Yes/No/ N/A
2.12 Print-ready illustrations/graphs/tables	Yes/No/ N/A	Yes/No/ N/A
2.13 Materials list provided (if relevant)	Yes/No/ N/A	Yes/No/ N/A

Criteria	Examine r	Moderator
2.14 Evidence required is clearly indicated	Yes/No/ N/A	Yes/No/ N/A
2.15 Task is cost-effective	Yes/No/ N/A	Yes/No/ N/A

CRITERION 3-8: Content, Cognitive Skills, Question Types, Language, Overall Impression, Assessment Tool

Each criterion follows the same format:

Criterion	Examine r	Moderator
[Insert itemized sub-criteria]	Yes/No/ N/A	Yes/No/ N/A

☐ Recommended Changes

Task

Item No.	Recommended Change	Motivation
-------------	-----------------------	------------

Task Status: ☐ APPROVED ☐ CONDITIONALLY APPROVED ☐ REJECTED

Assessment Tool

Item No.	Recommended Change	Motivation
-------------	-----------------------	------------

Tool Status: ☐ APPROVED ☐ CONDITIONALLY APPROVED ☐ REJECTED

General Comments

Lecturer Signature: _____ **Date:** _____ **Moderator Signature:** _____ **Date:** _____

☐ ANNEXURE G3: Post-Assessment Moderation Checklist

LECTURER:

MODERATOR:

SUBJECT:

ASSESSMENT TASK:

Moderation Details

Detail	Value
Number of students assessed	
Number of scripts moderated	
ID numbers and names of moderated students	
Student Name/ID Assessed Mark	Moderated Mark

Would you like me to generate a Visual Basic or Excel-compatible version of these tables for automated moderation tracking and reporting?

□ ANNEXURE G6: ICASS Irregularity Register Template

NAME OF COLLEGE:

EXAM CYCLE & YEAR:

DATE: _____

□ Irregularity Record Table

Centre No.	Centre Name	Student ID No.	Offering / Subject	Level	ICASS Task	Mark Sheet No.	Category of Action Irregularity Taken
------------	-------------	----------------	--------------------	-------	------------	----------------	---------------------------------------

□ Signatures and Verification

Role	Signature	Date
College Examinations Officer		
College Academic Head		
College Principal		

□ ANNEXURE S1: Semester Subject Assessment Plan

Subject Name	Semester No.	Assessment Task	Assessment Tool	Content Coverage	Duration & Mark Allocation	Lecturer	Mode	Pre-Assessment Submission Date	Assessment Date(s)	Post-Moderation Completion Date
		Test/Assignment	Memo/Rubric							
		Test/Assignment	Memo/Rubric							
		Internal Exam	Memo							

□ ANNEXURE S2: Semester Assessment Schedule for Students

Subject Name	Assessment No.	Assessment Task	Assessment Tool	Content Coverage	Duration & Mark Allocation	Assessment Date
	1	Assignment	Memo	80% Practical Component		
	2	Test	Memo	50% of Syllabus		
	3	Internal Exam	Memo	70-80% of Syllabus	≥ 1½ hours	

□ ANNEXURE S3: Semester Assessment Tasks Breakdown

Task No.	Type of Assessment Activity	Scope of Assessment	Contribution to ICASS Mark
1	Assignment / Practical Task	≥ 80% Practical Component	20%
2	Test	≥ 50% of Syllabus	30%
3	Internal Examination	≥ 70-80% of	50%

Task No.	Type of Assessment Activity	Scope of Assessment	Contribution to ICASS Mark
		Syllabus	
Total			100%

□ ANNEXURE S4: Rubric - Preparation of a Function Room

Task	Criteria	Level 4 (Outstanding)	Level 3 (Highly Competent)	Level 2 (Competent)	Level 1 (Not Yet Competent)	Student's Mark
1	Stocktaking	13-15 marks	10-12 marks	6-9 marks	0-5 marks	
2	Health, Hygiene & Safety	4-5 marks	3 marks	2 marks	0-1 mark	
3	Room Setup	7-8 marks	5-6 marks	4 marks	0-3 marks	
4	Time Management	6-7 marks	4-5 marks	3 marks	0-2 marks	
	Total					/35

□ ANNEXURE S5: ICASS Semester Record Sheet

Year:	Semester:	Lecturer:			
_____	_____	_____			
No Student ID	Surname & Initials	Assignment (20%)	Test (30%)	Internal Exam (50%)	Final ICASS Mark (100%)
1					
2					
...					
25					
.					

Table 1: 2023 TVET College New Entrants Who Wrote Grade 12 in 2022

Qualification Category	Bachelors	Diploma	Higher Certificate	Incomplete	Not Achieved NSC	Unspecified	Total
Report 191	10 372	15 363	5 771	7 394	471	1 092	40 463
NC(V)	730	1 604	1 374	4 679	2 525	1 094	12 006
Occupational Qualifications	359	371	206	289	260	65	1 550
Skills Programmes	121	141	58	68	29	22	439
PLP	22	85	103	228	200	37	675
Level 5 & Level 6 Qualifications	32	9	2	11	0	1	55
Total	11 636	17 573	7 514	12 669	3 485	2 311	55 188

Table 2: 2023 Report 191 Enrolments by Grade 12 Result Status

Report 191 Programme	Bachelors	Diploma	Higher Certificate	Incomplete	Not Achieved NSC	Unspecified	Total
Art and Design	6	8	5	2	0	1	22
Business Management	947	1 447	507	534	10	128	3 573
Clothing Production	24	26	26	25	0	3	104
Educare	128	239	95	108	6	23	599
Engineering Studies	4 558	6 503	2 447	3 513	378	306	17 705
Farming Management	169	268	98	118	1	25	679
Financial Management	777	887	240	511	10	102	2 527
Hospitality and Catering	297	462	151	154	6	26	1 096

Report 191 Programme	Bachel ors	Diplo ma	Higher Certifica te	Incompl ete	Not Achieve d NSC	Unspeci fied	Tota l
Services							
Human Resource Management	616	958	365	466	6	90	2 501
Legal Secretary	115	119	42	65	1	12	354
Management Assistant	506	923	387	462	11	116	2 405
Marketing Management	321	620	286	308	8	58	1 601
Medical Secretary	41	37	8	27	2	4	119
National Certificate N4: Intro Clothing	3	5	2	3	0	0	13
National Certificate (Orientation): Engineering	4	7	2	1	0	0	14
National Intro Cert: N4 Art and Design	6	20	6	8	0	0	40
National Intro Cert: N4 Business Studies	385	760	332	280	8	60	1 825
National Intro Cert: N4 Clothing Production	10	32	10	14	1	1	68
National Intro Cert: N4 Food Services	12	26	23	12	1	1	75
Popular Music: Composition	0	1	0	0	0	0	1
Popular Music: Performance	6	7	1	3	0	1	18
Popular	7	16	6	6	1	0	36

Report 191 Programme	Bachel ors	Diplo ma	Higher Certifica te	Incompl ete	Not Achieve d NSC	Unspeci fied	Tota l
Music: Studio Work							
Public Management	778	1 136	398	519	10	93	2 934
Public Relations	39	50	17	32	0	9	147
Tourism	617	806	317	223	11	33	2 007
Total	10 372	15 363	5 771	7 394	471	1 092	40 463

□ Visual Basic Code - TVET Enrolment Analysis & Moderation Tracker

vb

' Module: TVET_Enrolment_Analysis

' Purpose: Analyze 2023 TVET college enrolment data and support moderation tracking

Option Explicit

' Define structures

Type QualificationStats

Category As String

Bachelors As Long

Diploma As Long

HigherCert As Long

Incomplete As Long

NotAchieved As Long

Unspecified As Long

Total As Long

End Type

Type ProgrammeStats

Programme As String

Bachelors As Long

Diploma As Long

HigherCert As Long

Incomplete As Long

NotAchieved As Long

Unspecified As Long

Total As Long

End Type

Type ModerationRecord

StudentID As String

Subject As String

```

        AssessedMark As Integer
        ModeratedMark As Integer
    End Type

Type IrregularityRecord
    CentreNo As String
    CentreName As String
    StudentID As String
    Subject As String
    Level As String
    Task As String
    MarkSheetNo As String
    Category As String
    ActionTaken As String
End Type

' Declare arrays
Dim QualStats(1 To 6) As QualificationStats
Dim ProgStats() As ProgrammeStats
Dim ModRecords() As ModerationRecord
Dim IrregRecords() As IrregularityRecord

' Initialize qualification data
Sub InitializeQualificationStats()
    QualStats(1) = CreateQual("Report 191", 10372, 15363, 5771, 7394, 471,
1092)
    QualStats(2) = CreateQual("NC(V)", 730, 1604, 1374, 4679, 2525, 1094)
    QualStats(3) = CreateQual("Occupational Qualifications", 359, 371, 206,
289, 260, 65)
    QualStats(4) = CreateQual("Skills Programmes", 121, 141, 58, 68, 29, 22)
    QualStats(5) = CreateQual("PLP", 22, 85, 103, 228, 200, 37)
    QualStats(6) = CreateQual("Level 5 & 6 Qualifications", 32, 9, 2, 11, 0,
1)
End Sub

Function CreateQual(Category As String, B As Long, D As Long, H As Long, I As
Long, N As Long, U As Long) As QualificationStats
    Dim q As QualificationStats
    q.Category = Category
    q.Bachelors = B
    q.Diploma = D
    q.HigherCert = H
    q.Incomplete = I
    q.NotAchieved = N
    q.Unspecified = U
    q.Total = B + D + H + I + N + U
    CreateQual = q
End Function

' Display qualification summary
Sub DisplayQualificationStats()
    Dim i As Integer
    Debug.Print "□ 2023 TVET Enrolment by Qualification Category"
    Debug.Print "Category", "Bachelors", "Diploma", "HigherCert",
"Incomplete", "NotAchieved", "Unspecified", "Total"

```

```

        For i = 1 To 6
            With QualStats(i)

Debug.Print .Category, .Bachelors, .Diploma, .HigherCert, .Incomplete, .NotAc
hieved, .Unspecified, .Total
            End With
        Next i
    End Sub

' Add moderation record
Sub AddModerationRecord(StudentID As String, Subject As String, Assessed As
Integer, Moderated As Integer)
    Dim i As Integer
    i = UBound(ModRecords) + 1
    ReDim Preserve ModRecords(1 To i)
    ModRecords(i).StudentID = StudentID
    ModRecords(i).Subject = Subject
    ModRecords(i).AssessedMark = Assessed
    ModRecords(i).ModeratedMark = Moderated
End Sub

' Add irregularity record
Sub AddIrregularity(CentreNo As String, CentreName As String, StudentID As
String, Subject As String, Level As String, Task As String, SheetNo As
String, Category As String, Action As String)
    Dim i As Integer
    i = UBound(IrregRecords) + 1
    ReDim Preserve IrregRecords(1 To i)
    With IrregRecords(i)
        .CentreNo = CentreNo
        .CentreName = CentreName
        .StudentID = StudentID
        .Subject = Subject
        .Level = Level
        .Task = Task
        .MarkSheetNo = SheetNo
        .Category = Category
        .ActionTaken = Action
    End With
End Sub

' Display moderation summary
Sub DisplayModerationRecords()
    Dim i As Integer
    Debug.Print "[] Moderation Records"
    Debug.Print "StudentID", "Subject", "Assessed", "Moderated"
    For i = LBound(ModRecords) To UBound(ModRecords)
        With ModRecords(i)
            Debug.Print .StudentID, .Subject, .AssessedMark, .ModeratedMark
        End With
    Next i
End Sub

' Display irregularity register
Sub DisplayIrregularityRegister()

```

```

    Dim i As Integer
    Debug.Print "☐ ICASS Irregularity Register"
    Debug.Print "CentreNo", "CentreName", "StudentID", "Subject", "Level",
"Task", "SheetNo", "Category", "ActionTaken"
    For i = LBound(IrregRecords) To UBound(IrregRecords)
        With IrregRecords(i)
            Debug.Print .CentreNo, .CentreName, .StudentID, .Subject, .Level,
.Task, .MarkSheetNo, .Category, .ActionTaken
        End With
    Next i
End Sub

```

Would you like me to extend this module to include automated percentage calculations, export-ready summaries, or integration with your logigram audit sheets?

Copilot said

Here is a Visual Basic module that models the qualification rules and instructional offerings for the N2–N6 Engineering Studies qualifications. This code supports:

- ☐ Qualification rule validation (Category A–D)
- ☐ Instructional offering registration and categorization
- ☐ Learner eligibility check for certificate issuance
- ☐ Prohibited combination detection (e.g., Radar Systems + Radar Technology)

☐ Visual Basic Code - Qualification Rules & Offering Validator

```

vb
' Module: QualificationRulesValidator
' Purpose: Validate instructional offerings against qualification rules for
N2–N6 Engineering Studies

Option Explicit

' Define offering structure
Type InstructionalOffering
    Code As String
    Title As String
    Category As String ' A, B, C, D or "-"
End Type

' Define learner structure
Type LearnerOffering
    Code As String
    Category As String
End Type

```

```

Dim Offerings() As InstructionalOffering
Dim LearnerSubjects() As LearnerOffering

' Initialize sample offerings
Sub InitializeOfferings()
    ReDim Offerings(1 To 8)
    Offerings(1) = CreateOffering("11041872", "Electrical Trade Theory N2",
"A")
    Offerings(2) = CreateOffering("16030192", "Mathematics N2", "B")
    Offerings(3) = CreateOffering("15070402", "Engineering Science Theory
N2", "C")
    Offerings(4) = CreateOffering("8090272", "Engineering Drawing N2", "D")
    Offerings(5) = CreateOffering("8080602", "Industrial Electronics N2",
"A")
    Offerings(6) = CreateOffering("11022082", "Welders' Theory N2", "A")
    Offerings(7) = CreateOffering("11040012", "Plant Operation Theory N2",
"A")
    Offerings(8) = CreateOffering("5110002", "Communication N2", "-")
End Sub

Function CreateOffering(Code As String, Title As String, Category As String)
As InstructionalOffering
    Dim o As InstructionalOffering
    o.Code = Code
    o.Title = Title
    o.Category = Category
    CreateOffering = o
End Function

' Add learner subjects
Sub AddLearnerSubjects()
    ReDim LearnerSubjects(1 To 4)
    LearnerSubjects(1) = CreateLearnerSubject("11041872", "A")
    LearnerSubjects(2) = CreateLearnerSubject("16030192", "B")
    LearnerSubjects(3) = CreateLearnerSubject("15070402", "C")
    LearnerSubjects(4) = CreateLearnerSubject("8090272", "D")
End Sub

Function CreateLearnerSubject(Code As String, Category As String) As
LearnerOffering
    Dim s As LearnerOffering
    s.Code = Code
    s.Category = Category
    CreateLearnerSubject = s
End Function

' Validate qualification rule
Sub ValidateQualification()
    Dim hasA As Boolean, hasB As Boolean, hasC As Boolean, hasD As Boolean
    Dim i As Integer
    For i = LBound(LearnerSubjects) To UBound(LearnerSubjects)
        Select Case LearnerSubjects(i).Category
            Case "A": hasA = True
            Case "B": hasB = True
            Case "C": hasC = True

```

```

        Case "D": hasD = True
    End Select
Next i

Debug.Print "□ Qualification Rule Validation"
Debug.Print "Category A (Trade Theory):", IIf(hasA, "✓", "✗")
Debug.Print "Category B (Mathematics):", IIf(hasB, "✓", "✗")
Debug.Print "Category C (Science):", IIf(hasC, "✓", "✗")
Debug.Print "Category D (Drawing):", IIf(hasD, "✓", "✗")

If hasA And hasB And hasC And hasD Then
    Debug.Print "□ Learner meets qualification rules for certificate issuance."
Else
    Debug.Print "□ Learner does NOT meet qualification rules."
End If
End Sub

' Check prohibited combinations (example: N4 level)
Sub CheckProhibitedCombinations()
    Dim hasRadarSys As Boolean, hasRadarTech As Boolean
    Dim hasDigital As Boolean, hasLogic As Boolean
    Dim hasBuildConstr As Boolean, hasMechDraft As Boolean, hasSteelDraw As Boolean
    Dim i As Integer

    For i = LBound(LearnerSubjects) To UBound(LearnerSubjects)
        Select Case LearnerSubjects(i).Code
            Case "08010034": hasRadarSys = True
            Case "08010064": hasRadarTech = True
            Case "08080354": hasDigital = True
            Case "08080284": hasLogic = True
            Case "08060004": hasBuildConstr = True
            Case "08090204": hasMechDraft = True
            Case "08090124": hasSteelDraw = True
        End Select
    Next i

    Debug.Print "□ Prohibited Combination Check"
    If hasRadarSys And hasRadarTech Then Debug.Print "□ Radar Systems + Radar Technology not allowed."
    If hasDigital And hasLogic Then Debug.Print "□ Digital Electronics + Logic Systems not allowed."
    If hasBuildConstr And hasMechDraft And hasSteelDraw Then Debug.Print "□ Building + Mechanical Draughting + Steel Drawing not allowed."
End Sub

```

Would you like this module extended to include N3-N6 levels with dynamic learner input and exportable reports for audit or moderation?

:

□ Departmental Forms Archive Overview

□ **Category: Supplier & Registration Forms (2012)**

Form Title	Description
Registration form to register as a supplier	Used to enlist suppliers on the department's database

□ **Category: Private FET College Registration & Amendment (2008)**

Form Title	Description
FPX-01	Application form for registration of Private FET College
FPX-02	Application for amendment of registration
FPX-03	Schedule of fees
Guide FPX-01	Guide for completing FPX-01
Guide FPX-02	Guide for completing FPX-02

□ **Category: ELRC Labour Forms (2005)**

Form Code	Title
E1	Referral Form
E2	Application for Condonation
E3	Certificate of Outcome of Dispute
E4	Application for Rescission of Ruling
E5	Application for Variation of Ruling
E6	Condonation for Late Filing
E7	Application under Section 142A
E8	Certify ELRC Award & Writ of Execution
E9	Appoint Senior Panellist
E10	Subpoena
E11	Request for Taxation
E12	Pre-dismissal Arbitration
E13	Request for Arbitration
E14	Expedited Arbitration
E15	Condonation for Unfair Labour Practice
E16	Notice of Withdrawal of Dispute

Form Code	Title
E17	Expedited Dispute Resolution Notice

□ **Category: Other Labour & Quality Management Forms**

Form Title	Description
Form 7.20	Request for Section 189A Facilitation
IQMS	Integrated Quality Management System for Public FET Educators
LRA Form 9.2	Record of Strike, Lock-out or Protest Action
□ Structured data entry for Sections A, B1, B2, and B3 □ Validation of required fields and supporting documentation □ Modular tracking of new offerings, discontinuations, and Higher Certificate submissions □ Audit-ready summaries for council ratification and OHS compliance	

□ **Visual Basic Code - DHET Curriculum Application Tracker**

```
vb
' Module: DHET_CurriculumApplication
' Purpose: Capture and validate curriculum offering applications for DHET approval
```

```
Option Explicit
```

```
Type CollegeInfo
    Name As String
    Tel As String
    Address As String
    PrincipalName As String
    PrincipalCell As String
    PrincipalEmail As String
    CouncilChairName As String
    CouncilChairCell As String
    CouncilChairEmail As String
End Type
```

```
Type ManagementMember
    Name As String
    Designation As String
    Contact As String
End Type
```

```
Type OfferingRequest
    Qualification As String
```

```

        Programme As String
        Subjects As String
        Campus As String
        IsNewSite As Boolean
        ProviderCode As String
        ExamCentreNumber As String
End Type

Type DiscontinuationRequest
    Qualification As String
    Programme As String
    Subjects As String
    Campus As String
    Province As String
    GPS As String
    ProviderCode As String
    ExamCentreNumber As String
End Type

Type HigherCertRequest
    Qualification As String
    QualCode As String
    Subjects As String
    Campus As String
    IsNewSite As Boolean
End Type

Dim College As CollegeInfo
Dim Managers() As ManagementMember
Dim NewOfferings() As OfferingRequest
Dim DiscontinuedOfferings() As DiscontinuationRequest
Dim HigherCerts() As HigherCertRequest

' Initialize college info
Sub SetCollegeInfo()
    With College
        .Name = "Example TVET College"
        .Tel = "011 123 4567"
        .Address = "123 Main Street, Johannesburg"
        .PrincipalName = "Dr. M. Nkosi"
        .PrincipalCell = "082 123 4567"
        .PrincipalEmail = "principal@example.edu.za"
        .CouncilChairName = "Ms. T. Dlamini"
        .CouncilChairCell = "083 987 6543"
        .CouncilChairEmail = "chair@example.edu.za"
    End With
End Sub

' Add management member
Sub AddManager(Name As String, Role As String, Contact As String)
    Dim i As Integer
    i = IIf(IsArrayAllocated(Managers), UBound(Managers) + 1, 1)
    ReDim Preserve Managers(1 To i)
    Managers(i).Name = Name
    Managers(i).Designation = Role

```

```

        Managers(i).Contact = Contact
End Sub

Function IsArrayAllocated(arr As Variant) As Boolean
    On Error Resume Next
    IsArrayAllocated = IsArray(arr) And Not IsEmpty(arr) And Not
    IsError(LBound(arr)) And LBound(arr) <= UBound(arr)
End Function

' Add new qualification offering
Sub AddNewOffering(Qual As String, Prog As String, Subs As String, Campus As
String, IsNew As Boolean, Code As String, Centre As String)
    Dim i As Integer
    i = IIf(IsArrayAllocated(NewOfferings), UBound(NewOfferings) + 1, 1)
    ReDim Preserve NewOfferings(1 To i)
    With NewOfferings(i)
        .Qualification = Qual
        .Programme = Prog
        .Subjects = Subs
        .Campus = Campus
        .IsNewSite = IsNew
        .ProviderCode = Code
        .ExamCentreNumber = Centre
    End With
End Sub

' Add discontinuation
Sub AddDiscontinuation(Qual As String, Prog As String, Subs As String, Campus
As String, Prov As String, GPS As String, Code As String, Centre As String)
    Dim i As Integer
    i = IIf(IsArrayAllocated(DiscontinuedOfferings),
UBound(DiscontinuedOfferings) + 1, 1)
    ReDim Preserve DiscontinuedOfferings(1 To i)
    With DiscontinuedOfferings(i)
        .Qualification = Qual
        .Programme = Prog
        .Subjects = Subs
        .Campus = Campus
        .Province = Prov
        .GPS = GPS
        .ProviderCode = Code
        .ExamCentreNumber = Centre
    End With
End Sub

' Add Higher Certificate offering
Sub AddHigherCert(Qual As String, Code As String, Subs As String, Campus As
String, IsNew As Boolean)
    Dim i As Integer
    i = IIf(IsArrayAllocated(HigherCerts), UBound(HigherCerts) + 1, 1)
    ReDim Preserve HigherCerts(1 To i)
    With HigherCerts(i)
        .Qualification = Qual
        .QualCode = Code
        .Subjects = Subs
    End With
End Sub

```

```

        .Campus = Campus
        .IsNewSite = IsNew
    End With
End Sub

' Display summary
Sub DisplayApplicationSummary()
    Debug.Print "□ DHET Curriculum Application Summary"
    Debug.Print "College:", College.Name
    Debug.Print "Principal:", College.PrincipalName, "| Email:",
College.PrincipalEmail
    Debug.Print "Council Chair:", College.CouncilChairName, "| Email:",
College.CouncilChairEmail
    Debug.Print "New Offerings:", UBound(NewOfferings)
    Debug.Print "Discontinuations:", UBound(DiscontinuedOfferings)
    Debug.Print "Higher Certificates:", UBound(HigherCerts)
End Sub

```

Would you like this module extended to include Section C (site creation/closure), Section D (delivery mode), and Section E (trade test centre declaration)? I can also scaffold a printable summary for submission to DHET.

Copilot said

Thanks for sharing the full structure of the DHET application. Based on this, I've expanded the Visual Basic module to include structured data entry and validation for:

- □ Section A: General Information and Summary
- □ Section B1: New Qualification, Programme, and Subject Offerings
- □ Section B2: Discontinuation of Offerings
- □ Section B3: Higher Certificate Offerings

This module supports modular tracking, audit readiness, and council submission preparation.

□ Visual Basic Code - DHET Curriculum Application (Expanded)

```

vb
' Module: DHET_CurriculumApplication_Expanded
' Purpose: Capture and validate Sections A–B3 of DHET curriculum application

Option Explicit

' Section A: College Info and Summary
Type CollegeSummary
    CollegeName As String

```

```

    Tel As String
    Address As String
    PrincipalName As String
    PrincipalCell As String
    PrincipalEmail As String
    CouncilChairName As String
    CouncilChairCell As String
    CouncilChairEmail As String
    SubmissionDate As Date
End Type

Type ManagementMember
    Name As String
    Designation As String
    ContactDetails As String
End Type

Type SummaryEntry
    Category As String
    OfferingName As String
    Campus As String
    ImplementationDate As Date
End Type

' Section B1: New Offerings
Type NewOffering
    Qualification As String
    Programme As String
    Subjects As String
    Campus As String
    IsNewSite As Boolean
    ProviderCode As String
    ExamCentreNumber As String
    EnrolmentComment As String
    ReadinessComment As String
    OHSComent As String
    CouncilApprovalComment As String
End Type

' Section B2: Discontinuations
Type DiscontinuedOffering
    Qualification As String
    Programme As String
    Subjects As String
    Campus As String
    Province As String
    GPS As String
    ProviderCode As String
    ExamCentreNumber As String
    EnrolmentComment As String
    ImpactComment As String
    PhaseOutComment As String
    CouncilApprovalComment As String
End Type

```

```

' Section B3: Higher Certificate
Type HigherCertificateOffering
    Qualification As String
    QualificationCode As String
    Subjects As String
    Campus As String
    IsNewSite As Boolean
End Type

' Declare arrays
Dim College As CollegeSummary
Dim Managers() As ManagementMember
Dim SummaryItems() As SummaryEntry
Dim NewOfferings() As NewOffering
Dim DiscontinuedOfferings() As DiscontinuedOffering
Dim HigherCerts() As HigherCertificateOffering

' Add summary item
Sub AddSummaryItem(Category As String, Offering As String, Campus As String,
StartDate As Date)
    Dim i As Integer
    i = IIf(IsArrayAllocated(SummaryItems), UBound(SummaryItems) + 1, 1)
    ReDim Preserve SummaryItems(1 To i)
    With SummaryItems(i)
        .Category = Category
        .OfferingName = Offering
        .Campus = Campus
        .ImplementationDate = StartDate
    End With
End Sub

' Add new offering
Sub AddNewOffering(Qual As String, Prog As String, Subs As String, Campus As
String, IsNew As Boolean, Code As String, Centre As String, Enrol As String,
Ready As String, OHS As String, Council As String)
    Dim i As Integer
    i = IIf(IsArrayAllocated(NewOfferings), UBound(NewOfferings) + 1, 1)
    ReDim Preserve NewOfferings(1 To i)
    With NewOfferings(i)
        .Qualification = Qual
        .Programme = Prog
        .Subjects = Subs
        .Campus = Campus
        .IsNewSite = IsNew
        .ProviderCode = Code
        .ExamCentreNumber = Centre
        .EnrolmentComment = Enrol
        .ReadinessComment = Ready
        .OHSComent = OHS
        .CouncilApprovalComment = Council
    End With
End Sub

' Add discontinued offering

```

```

Sub AddDiscontinuedOffering(Qual As String, Prog As String, Subs As String,
Campus As String, Prov As String, GPS As String, Code As String, Centre As
String, Enrol As String, Impact As String, PhaseOut As String, Council As
String)
    Dim i As Integer
    i = IIf(IsArrayAllocated(DiscontinuedOfferings),
UBound(DiscontinuedOfferings) + 1, 1)
    ReDim Preserve DiscontinuedOfferings(1 To i)
    With DiscontinuedOfferings(i)
        .Qualification = Qual
        .Programme = Prog
        .Subjects = Subs
        .Campus = Campus
        .Province = Prov
        .GPS = GPS
        .ProviderCode = Code
        .ExamCentreNumber = Centre
        .EnrolmentComment = Enrol
        .ImpactComment = Impact
        .PhaseOutComment = PhaseOut
        .CouncilApprovalComment = Council
    End With
End Sub

' Add Higher Certificate offering
Sub AddHigherCert(Qual As String, Code As String, Subs As String, Campus As
String, IsNew As Boolean)
    Dim i As Integer
    i = IIf(IsArrayAllocated(HigherCerts), UBound(HigherCerts) + 1, 1)
    ReDim Preserve HigherCerts(1 To i)
    With HigherCerts(i)
        .Qualification = Qual
        .QualificationCode = Code
        .Subjects = Subs
        .Campus = Campus
        .IsNewSite = IsNew
    End With
End Sub

' Utility
Function IsArrayAllocated(arr As Variant) As Boolean
    On Error Resume Next
    IsArrayAllocated = IsArray(arr) And Not IsEmpty(arr) And Not
IsError(LBound(arr)) And LBound(arr) <= UBound(arr)
End Function

```

Would you like me to scaffold Section C (site creation/closure), Section D (delivery mode), and Section E (trade test centre declaration) next? I can also help generate a printable summary for DHET submission.

You said

nated dhett n diploma statement and certificate , n diploma n1,2,3,4,5,6
engineering electrical visual basic code

Copilot said

To support the generation and validation of a DHET-aligned NATED National Diploma statement and certificate for Engineering Studies (Electrical), covering levels N1 through N6, here's a Visual Basic module that:

- □ Tracks subject completion across N1–N6
- □ Calculates eligibility for the National N Diploma
- □ Generates a structured statement of results
- □ Flags readiness for certificate issuance based on DHET rules

□ Visual Basic Code - NATED Electrical Engineering Diploma Tracker

```
vb
' Module: NATED_ElectricalDiploma
' Purpose: Validate N1–N6 completion and generate statement for DHET National
N Diploma (Engineering Electrical)

Option Explicit

' Define subject record
Type SubjectRecord
    Level As String ' N1 to N6
    SubjectCode As String
    SubjectName As String
    Mark As Integer
    Passed As Boolean
End Type

' Define learner record
Type LearnerRecord
    StudentID As String
    FullName As String
    Subjects() As SubjectRecord
    PracticalCompleted As Boolean
End Type

Dim Learner As LearnerRecord

' Initialize learner
Sub InitializeLearner(ID As String, Name As String)
    Learner.StudentID = ID
    Learner.FullName = Name
    ReDim Learner.Subjects(1 To 18) ' 3 subjects per level x 6 levels
End Sub
```



```

' Add subject result
Sub AddSubject(Level As String, Code As String, Name As String, Mark As Integer)
    Dim i As Integer
    i = GetNextSubjectIndex()
    Learner.Subjects(i).Level = Level
    Learner.Subjects(i).SubjectCode = Code
    Learner.Subjects(i).SubjectName = Name
    Learner.Subjects(i).Mark = Mark
    Learner.Subjects(i).Passed = (Mark >= 50)
End Sub

Function GetNextSubjectIndex() As Integer
    Dim i As Integer
    For i = LBound(Learner.Subjects) To UBound(Learner.Subjects)
        If Learner.Subjects(i).SubjectCode = "" Then
            GetNextSubjectIndex = i
            Exit Function
        End If
    Next i
End Function

' Check diploma eligibility
Sub CheckDiplomaEligibility()
    Dim levelCount(1 To 6) As Integer
    Dim passedCount As Integer
    Dim i As Integer
    For i = LBound(Learner.Subjects) To UBound(Learner.Subjects)
        If Learner.Subjects(i).Passed Then
            passedCount = passedCount + 1
            Select Case Learner.Subjects(i).Level
                Case "N1": levelCount(1) = levelCount(1) + 1
                Case "N2": levelCount(2) = levelCount(2) + 1
                Case "N3": levelCount(3) = levelCount(3) + 1
                Case "N4": levelCount(4) = levelCount(4) + 1
                Case "N5": levelCount(5) = levelCount(5) + 1
                Case "N6": levelCount(6) = levelCount(6) + 1
            End Select
        End If
    Next i

    Debug.Print "□ NATED Electrical Engineering Diploma Eligibility"
    Debug.Print "Student:", Learner.FullName, "| ID:", Learner.StudentID
    Debug.Print "Subjects Passed:", passedCount
    Debug.Print "Practical Completed:", IIf(Learner.PracticalCompleted, "✓", "x")

    If levelCount(4) >= 3 And levelCount(5) >= 3 And levelCount(6) >= 3 And Learner.PracticalCompleted Then
        Debug.Print "□ Eligible for National N Diploma (Engineering Electrical)"
    Else
        Debug.Print "□ Not yet eligible. Check subject spread and practical completion."
    End If
End Sub

```

```

        End If
    End Sub

' Generate statement of results
Sub GenerateStatement()
    Dim i As Integer
    Debug.Print "□ Statement of Results – Engineering Electrical"
    Debug.Print "Student:", Learner.FullName, "| ID:", Learner.StudentID
    Debug.Print "-----"
    Debug.Print "Level", "Code", "Subject", "Mark", "Status"
    For i = LBound(Learner.Subjects) To UBound(Learner.Subjects)
        If Learner.Subjects(i).SubjectCode <> "" Then
            Debug.Print Learner.Subjects(i).Level,
Learner.Subjects(i).SubjectCode, Learner.Subjects(i).SubjectName,
Learner.Subjects(i).Mark, IIf(Learner.Subjects(i).Passed, "Pass", "Fail")
        End If
    Next i
    Debug.Print "-----"
End Sub

```

This module can be extended to include:

- □ Export-ready certificate formatting
- □ Weighted average calculations
- □ Integration with DHET EMIS and exam centre codes

Would you like to add a form-based interface for entering subject results or automate certificate generation for multiple learners?

.

□ National N Diploma: Electrical Engineering - Qualification Pathway

□ DHET Requirements for Diploma Issuance

According to DHET guidelines

, a candidate must:

- **Pass at least 12 subjects** from N4, N5, and N6 levels (minimum 4 per level recommended)
- **Include at least 2 instructional offerings per level** that are relevant to the trade
- **Submit proof of 24 months of workplace experience** in a relevant engineering environment
- **Resolve any subject irregularities** (e.g. N4 Electrical Trade Theory) before diploma issuance

- **Complete and submit a workplace logbook** signed by the employer

□ Subject Combinations (Electrical Engineering)

Level	Core Subjects (Examples)
1	
N1–N3	Engineering Drawing, Engineering Science, Industrial Orientation, Electrical Theory (not counted toward diploma but foundational)
N4	Electrical Trade Theory, Electrotechnics, Engineering Science, Industrial Electronics
N5	Electrical Trade Theory, Electrotechnics, Power Machines, Control Systems
N6	Electrical Trade Theory, Electrotechnics, Digital Electronics, Operational Plant

Note: Subjects like **Engineering Drawing N1–N3**, **Industrial Orientation**, and **Operational Plant** support foundational learning but **only N4–N6 subjects count toward the diploma**.

□ Statement of Results and Diploma Issuance

To generate a valid **Statement of Results** and apply for the **National N Diploma**, the candidate must:

- Ensure all **N4–N6 subjects are passed** (minimum 50%)
- Submit a **record of workplace experience** (logbook, signed and dated)
- Resolve any **irregularities** (e.g. N4 Electrical Trade Theory backlog or printer error)
- Apply through the **examination centre** with:
 - Certified ID copy
 - N4–N6 certificates or statements
 - Logbook and employer letter
 - DHET application form

□ Replacement and Backlog Resolution

If a subject like **Electrical Trade Theory N4** was affected by an irregularity (e.g. printer backlog or exam error), the following steps apply:

- Submit an **irregularity resolution certificate** from the college

- Ensure the subject is **re-captured and verified** in the DHET system
- Include the corrected result in the **final statement of results**

□ Workplace Experience & Logbook

Requirement	Details
Duration	24 months (Engineering)
Format	Logbook with tasks, dates, supervisor signature
Content	Electrical installation, fault finding, plant operation, control systems
Submission	With diploma application to DHET via college

Would you like help designing a Visual Basic module to track subject completion, logbook entries, and generate a printable diploma readiness report?

Based on the DHET requirements for the National N Diploma in Electrical Engineering, here is a Visual Basic module that:

- □ Tracks N4–N6 subject completion and pass status
- □ Validates diploma eligibility (minimum 12 subjects, 4 per level)
- □ Flags irregularities and backlog resolutions
- □ Records 24-month workplace experience and logbook status
- □ Generates a diploma readiness summary

□ Visual Basic Code - DHET Electrical Engineering Diploma Validator

```
vb
' Module: ElectricalDiplomaValidator
' Purpose: Validate N4–N6 subject completion, workplace experience, and
irregularity resolution for DHET diploma
```

```
Option Explicit
```

```
Type SubjectRecord
    Level As String ' N4, N5, N6
    SubjectCode As String
    SubjectName As String
    Mark As Integer
    Passed As Boolean
    IrregularityResolved As Boolean
End Type
```

```
Type LearnerRecord
```

```

        StudentID As String
        FullName As String
        Subjects() As SubjectRecord
        WorkplaceMonths As Integer
        LogbookSubmitted As Boolean
    End Type

    Dim Learner As LearnerRecord

    ' Initialize learner
    Sub InitializeLearner(ID As String, Name As String)
        Learner.StudentID = ID
        Learner.FullName = Name
        ReDim Learner.Subjects(1 To 18) ' Up to 6 per level
    End Sub

    ' Add subject
    Sub AddSubject(Level As String, Code As String, Name As String, Mark As Integer, IrregularityResolved As Boolean)
        Dim i As Integer
        i = GetNextSubjectIndex()
        With Learner.Subjects(i)
            .Level = Level
            .SubjectCode = Code
            .SubjectName = Name
            .Mark = Mark
            .Passed = (Mark >= 50)
            .IrregularityResolved = IrregularityResolved
        End With
    End Sub

    Function GetNextSubjectIndex() As Integer
        Dim i As Integer
        For i = LBound(Learner.Subjects) To UBound(Learner.Subjects)
            If Learner.Subjects(i).SubjectCode = "" Then
                GetNextSubjectIndex = i
                Exit Function
            End If
        Next i
    End Function

    ' Set workplace experience
    Sub SetWorkplaceExperience(Months As Integer, LogbookStatus As Boolean)
        Learner.WorkplaceMonths = Months
        Learner.LogbookSubmitted = LogbookStatus
    End Sub

    ' Validate diploma eligibility
    Sub ValidateDiploma()
        Dim levelCount(4 To 6) As Integer
        Dim totalPassed As Integer
        Dim i As Integer
        Dim irregularitiesResolved As Boolean: irregularitiesResolved = True

        For i = LBound(Learner.Subjects) To UBound(Learner.Subjects)

```

```

    If Learner.Subjects(i).Passed Then
        totalPassed = totalPassed + 1
        Select Case Learner.Subjects(i).Level
            Case "N4": levelCount(4) = levelCount(4) + 1
            Case "N5": levelCount(5) = levelCount(5) + 1
            Case "N6": levelCount(6) = levelCount(6) + 1
        End Select
    End If
    If Not Learner.Subjects(i).IrregularityResolved Then
        irregularitiesResolved = False
    End If
Next i

Debug.Print "□ Diploma Eligibility Summary"
Debug.Print "Student:", Learner.FullName, " | ID:", Learner.StudentID
Debug.Print "Subjects Passed:", totalPassed
Debug.Print "N4 Passed:", levelCount(4), " | N5 Passed:", levelCount(5),
" | N6 Passed:", levelCount(6)
Debug.Print "Workplace Experience:", Learner.WorkplaceMonths & " months"
Debug.Print "Logbook Submitted:", IIf(Learner.LogbookSubmitted, "✓",
"✗")
Debug.Print "Irregularities Resolved:", IIf(irregularitiesResolved, "✓",
"✗")

    If totalPassed >= 12 And levelCount(4) >= 4 And levelCount(5) >= 4 And
levelCount(6) >= 4 _
        And Learner.WorkplaceMonths >= 24 And Learner.LogbookSubmitted And
irregularitiesResolved Then
        Debug.Print "□ Eligible for DHET National N Diploma in Electrical
Engineering"
    Else
        Debug.Print "□ Not yet eligible – check subject spread, experience,
or unresolved issues"
    End If
End Sub

```

Would you like this module extended to generate a printable Statement of Results or integrate with your backlog resolution and logbook tracking system?

This is a structured research framework for an RNF/SARO-aligned engineering qualification pathway in Electrical Technology, integrating NATED, SAQA, UCPD, and postgraduate levels (Diploma, Master's, Doctoral). It includes a research statement, methodology, system modeling, and Visual Basic logic for curriculum automation and investigative simulation.

□ **Overview: RNF/SARO-Aligned Electrical Engineering Qualification Framework**

□ **Scope and Description**

This framework supports the development, validation, and automation of engineering qualifications across multiple levels:

- **NATED (Report 191):** N1–N6 Electrical Engineering
- **SAQA-registered Diplomas:** National N Diploma, Occupational Diplomas
- **UCPD:** Unit-Credit Progression Design for modular recognition
- **Postgraduate Pathways:** Master's and Doctoral research in Electrical Technology

It aligns with RNF (Recognition and Framework) and SARO (South African Research Outputs) for traceable, credential-linked learning.

□ **Research Statement**

Title: “Modular Integration and Fault Simulation in Electrical Engineering Education: A SAQA-Aligned RNF Framework”

Problem: Fragmented qualification pathways and lack of system-based fault simulation in electrical curricula hinder trade test readiness and postgraduate articulation.

Objective: To design a modular, SAQA-aligned system that integrates NATED, UCPD, and postgraduate research using logigram automation and Visual Basic modeling.

□ **Methodology**

Phase	Description
1. Curriculum Mapping	Align N1-N6 subjects to SAQA outcomes and UCPD modules
2. Logigram Design	Visualize learning flow, fault tracing, and system logic
3. Algorigram Modeling	Simulate decision paths for trade test and research validation
4. Visual Basic Automation	Build ICASS, promotion, and fault simulation modules
5. Scene Investigation	Apply collision and fault scenarios to real-world simulations
6. Data Analysis	Evaluate learner performance, irregularity resolution, and system response

□ Investigation Principles

- **Collision/Incidence Simulation:** Use fault tracing in AC/DC machines, transformers, and earthing systems
- **Scene Reconstruction:** Apply logigram logic to simulate missing neutral, overload, or generator failure
- **Data Analysis:** Use ICASS and exam data to validate promotion and diploma readiness

□ Visual Basic Code Snippet - Fault Simulation & Promotion Logic

```

vb
' Promotion Eligibility
Sub CheckPromotion(ICASS As Double, ExamMark As Double)
    Dim PromotionMark As Double
    PromotionMark = (ICASS * 0.4) + (ExamMark * 0.6)
    If PromotionMark >= 40 Then
        MsgBox "□ Eligible for diploma issuance"
    Else
        MsgBox "□ Not eligible – improve marks"
    End If
End Sub

' Generator Load Sharing
Sub CalculateLoadShare(totalLoad As Double, gen1Capacity As Double,
gen2Capacity As Double)
    Dim gen1Share As Double, gen2Share As Double
    gen1Share = (gen1Capacity / (gen1Capacity + gen2Capacity)) * totalLoad
    gen2Share = totalLoad - gen1Share
    MsgBox "Gen1: " & gen1Share & " kW | Gen2: " & gen2Share & " kW"
End Sub

' Missing Neutral Fault

```



```
Sub MissingNeutralImpact()
```

```
MsgBox "⚠ Missing neutral detected. Voltage imbalance and equipment risk  
pre
```

Here's a structured English synthesis of the Electrotechnics N6 syllabus (Report 191, January 2021), integrating its technical content with research methodology, system modeling, and Visual Basic logic for curriculum automation, fault simulation, and trade test readiness.

□ Overview: Electrotechnics N6 - DHET Report 191

□ Scope and Purpose

Electrotechnics N6 equips learners with advanced theoretical and practical skills for the electrical industry. It emphasizes:

- Circuit construction and fault diagnosis
- DC and AC machine operation
- Transformer and power system analysis
- Safety, efficiency, and standards compliance

□ Curriculum Structure

Section	Details
Prerequisite	Passed Electrotechnics N5
Duration	10 weeks, 6 hours/week (full-time or part-time)
Evaluation	2 formal tests + final exam (40% ICASS + 60% Exam = Promotion mark)
Exam Format	3 hours, closed book, formula sheet provided, scientific calculator
Assessment Weighting	Remembering 5-10%, Understanding 5-10%, Applying 40-45%, Analyzing 20-25%, Evaluating 5-10%, Creating 5-10%

□ Module Weighting

Module	Calculation	Theory	Total
DC Machines	±10%	±5%	±15%
AC Theory	±13%	±2%	±15%
Transformers	±10%	±5%	±15%

Module	Calculation	Theory	Total
			%
AC Machines	±25%	±5%	±30%
Generation & Supply of AC Power	±20%	±5%	±25%
Total	±78%	±22%	100%

□ Research Statement and Methodology

□ Research Focus

- **Topic:** Simulation and fault analysis in Electrotechnics N6 modules
- **Method:** Mixed-method approach using syllabus mapping, logigram design, and Visual Basic modeling
- **Data Sources:** DHET syllabus, ICASS records, fault logs, generator load data

□ Methodological Steps

1. **Curriculum Mapping:** Align learning outcomes to workplace tasks
2. **Logigram/Algorigram Design:** Visualize generator load sharing, transformer testing, and AC fault tracing
3. **System Modeling:** Use Visual Basic to simulate speed control, load balancing, and efficiency testing
4. **Scene Investigation:** Apply AC fault scenarios (e.g., missing neutral) to real-world simulations
5. **Data Analysis:** Evaluate learner performance, system response, and irregularity resolution

□ Investigation Principles and System Logic

Principle	Application
DC Machines	Speed control, load sharing, efficiency testing
AC Theory	Unbalanced loads, missing neutral, vector diagrams
Transformers	Parallel operation, loading conditions, kVA rating
AC Machines	Efficiency, construction, fault diagnosis

Principle	Application
Power Supply	Transmission line losses, consumer delivery

□ Logigram & Algorigram Integration (Visual Basic Logic)

```

vb
' Generator Load Sharing Logigram
Sub CalculateLoadShare(totalLoad As Double, gen1Capacity As Double,
gen2Capacity As Double)
    Dim gen1Share As Double, gen2Share As Double
    gen1Share = (gen1Capacity / (gen1Capacity + gen2Capacity)) * totalLoad
    gen2Share = totalLoad - gen1Share
    MsgBox "Generator 1 supplies: " & gen1Share & " kW" & vbCrLf & "Generator
2 supplies: " & gen2Share & " kW"
End Sub

' DC Motor Speed Control Algorigram
Function CalculateSpeed(V As Double, E As Double, Flux As Double) As Double
    ' Speed  $\propto (V - E) / \text{Flux}$ 
    CalculateSpeed = (V - E) / Flux
End Function

' Missing Neutral Fault Simulation
Sub MissingNeutralImpact()
    MsgBox "⚠ Missing neutral detected. Expect voltage imbalance and
potential equipment damage."
End Sub

' Promotion Eligibility
Sub CheckPromotion(ICASS As Double, ExamMark As Double)
    Dim PromotionMark As Double
    PromotionMark = (ICASS * 0.4) + (ExamMark * 0.6)
    If PromotionMark >= 40 Then
        MsgBox "□ Eligible for promotion"
    Else
        MsgBox "□ Not eligible – improve marks"
    End If
End Sub

```

Here's a structured English translation and synthesis of the Electrical Trade Theory N3 syllabus (September 2021), integrating curriculum content with research methodology, system design, and Visual Basic logic modeling. This framework supports modular delivery, investigative learning, and logigram/algorigram automation for engineering education and trade test readiness.

□ Overview: Electrical Trade Theory N3 - DHET Report 191

□ Scope and Purpose

Electrical Trade Theory N3 builds on N2 and prepares learners for advanced electrical environments. It integrates theoretical knowledge with practical application across domestic, industrial, and utility contexts.

General Aims

- Equip learners for:
 - Electrical apprenticeship and learnership
 - Contracting and power utility environments

Specific Aims

- Develop competence in:
 - AC circuit theory (balanced/unbalanced)
 - Domestic appliances and lighting systems
 - Programmable logic control
 - DC and AC machines
 - Transformers and earthing
 - Power management and renewable energy

□ Curriculum Structure

□ Admission & Duration

- **Prerequisite:** Passed N2
- **Duration:** One trimester (full-time, part-time, or distance)

□ Evaluation Breakdown

Component	Details
ICASS	2 tests/assignments (30% + 70%) – Minimum 40% to qualify for exam
Examination	3 hours, 100 marks, closed book – Minimum 40% to pass
Promotion Mark	40% of ICASS + 60% of Exam
Assessment Weighting	Recall 50%, Understanding 10%, Application 25%, Evaluation 15%

□ Module Weighting

Module	Description	Weight (%)
1	AC Circuit Theory	18
2	Domestic Appliances	12
3	Lighting Systems	8
4	Programmable Logic Control	5
5	DC Machines	15
6	AC Machines	10
7	Transformers	10
8	Earthing Systems	10
9	Power Management	7
10	Renewable Energy	5
	Total	100%

□ Research Statement and Methodology

□ Research Focus

- **Topic:** Integration of Electrical Trade Theory N3 into modular learning and system simulation
- **Method:** Mixed-method approach combining syllabus analysis, logigram modeling, and Visual Basic prototyping
- **Data Sources:** DHET syllabus, ICASS records, incident reports, appliance schematics

□ Methodological Steps

1. **Curriculum Mapping:** Align modules to workplace tasks and trade test outcomes
2. **Logigram/Algorigram Design:** Visualize appliance operation, fault tracing, and circuit behavior
3. **System Modeling:** Use Visual Basic to simulate ICASS evaluation, power factor correction, and appliance control
4. **Scene Investigation:** Apply modules to collision or fault scenarios (e.g. poor earthing, overload)
5. **Data Analysis:** Evaluate learner performance, irregularity resolution, and system response

□ Investigation Principles and System Logic

Principle	Application
AC Circuit Theory	Module 1: Impedance, resonance, power factor
Appliance Control	Module 2: Induction cookers, geyser thermostats
Lighting Systems	Module 3: Halogen, metal halide, LED
Fault Simulation	Module 8: Earthing chain, leakage current
Energy Optimization	Module 9-10: Power management, renewable integration

□ Logigram & Algorigram Integration (Visual Basic Logic)

```

vb
' Power Factor Correction Logigram
Sub CorrectPowerFactor(pf As Double)
    If pf < 0.9 Then
        MsgBox "⚠ Poor power factor detected. Add capacitive load to improve efficiency."
    Else
        MsgBox "✅ Power factor acceptable."
    End If
End Sub

' ICASS Evaluation Algorigram
Function CalculateICASS(Test1 As Integer, Test2 As Integer) As Double
    Dim ICASSMark As Double
    ICASSMark = (Test1 * 0.3) + (Test2 * 0.7)
    CalculateICASS = ICASSMark
End Function

' Promotion Eligibility
Sub CheckPromotion(ICASS As Double, ExamMark As Double)
    Dim PromotionMark As Double
    PromotionMark = (ICASS * 0.4) + (ExamMark * 0.6)
    If PromotionMark >= 40 Then
        MsgBox "✅ Eligible for promotion"
    Else
        MsgBox "❌ Not eligible – improve marks"
    End If
End Sub

```

□ Conclusion and Bibliographic

Here's a structured summary and translation of Modules 8-11 from the Electrical Trade Theory N2 syllabus (May 2021), aligned with DHET Report 191. This version integrates technical learning outcomes with system

design, investigative principles, and curriculum mapping for modular delivery and logigram automation.

□ **Electrical Trade Theory N2 - Modules 8 to 11 Overview**

□ **Module 8: Transformers**

General Aim Equip learners with knowledge of transformer function, construction, operation, and configuration.

Key Learning Outcomes

- **Single-phase transformers:**
 - Function: voltage transformation, current regulation
 - Construction: core, windings, insulation (diagram required)
 - Operation: circuit and vector diagrams (no-load)
 - Calculations: turns ratio, kVA rating, core-loss and magnetising components
- **Three-phase transformers:**
 - Configurations: Star/Star, Star/Delta, Delta/Delta, Delta/Star
 - Application: Residential distribution (typically Star/Delta)
 - Calculations: rating and turns ratio (ideal conditions)

□ **Module 9: Earthing**

General Aim Develop understanding of electrical safety through earthing systems and leakage current control.

Key Learning Outcomes

- **Earthing chain:**
 - Leakage current: definition and flow path
 - Concepts: bonding to earth, floating earth, touch voltage

- o Drawing: show current path to ground
- **Earthing methods:**
 - o Overhead lines: grounding techniques
 - o Underground cables: wire-armoured and lead-sheathed earthing

□ **Module 10: Measuring Instruments**

General Aim Teach learners how to connect and use measuring instruments in electrical circuits.

Key Learning Outcomes

- **Low-voltage circuits:**
 - o Instruments: ammeter, voltmeter, wattmeter, power factor meter, frequency meter, energy meter
 - o Diagrams: connection methods
- **High-voltage circuits:**
 - o Same instruments, adapted for HV applications
- **Range extension:**
 - o Galvanometer: definition and use for current/voltage scaling
- **Digital instruments:**
 - o Usage, care, maintenance
 - o Advantages vs disadvantages of digital vs analogue

✱ **Module 11: Renewable Energy**

General Aim Introduce learners to renewable energy sources and their role in electricity generation.

Key Learning Outcomes

- Differentiate between renewable and non-renewable energy

- Explain electricity generation from renewable sources (excluding solar)
- Draw layout of a renewable energy power plant (e.g. hydro, wind, biomass)

□ **Integration with Logigram & System Design**

These modules can be mapped into a modular curriculum framework using Visual Basic logic for:

- **Transformer testing simulation**
- **Earthing fault tracing**
- **Instrument connection validation**
- **Renewable energy plant layout automation**

Would you like a Visual Basic module that simulates transformer testing and earthing fault tracing using circuit logic and logigram flow?

□ **Overview: Electrical Trade Theory N2 - DHET Report 191 (May 2021)**

□ **General and Specific Aims**

- **General Aim:** Equip learners with theoretical knowledge to integrate into electrical apprenticeships, learnerships, and industrial environments.
- **Specific Aims:** Develop competence in:
 - AC and DC theory
 - Electrical machines and transformers
 - Reticulation, switchgear, and protective devices
 - Renewable energy and measuring instruments

□ **Curriculum Structure**

□ **Admission & Duration**

- **Prerequisite:** Passed N1
- **Duration:** One trimester (full-time, part-time, or distance)

□ Evaluation Breakdown

Component	Details
ICASS	2 tests/assignments (30% + 70%) – Minimum 40% to qualify for exam
Examination	3 hours, 100 marks, closed book – Minimum 40% to pass
Promotion Mark	40% of ICASS + 60% of Exam
Assessment Weighting	Recall 55%, Understanding 15%, Application 20%, Evaluation 10%

□ Module Weighting (Trimester Content)

Module	Description	Weight (%)
1	Alternating current circuit theory	12
2	Conductors, insulators and cables	12
3	Electrical reticulation	8
4	Switchgear and protective devices	10
5	Batteries	10
6	Direct current machines	10
7	Alternating current machines	8
8	Transformers	10
9	Earthing	10
10	Measuring instruments	6
11	Renewable energy	4
	Total	100%

□ Sample Module Breakdown

Module 1: Alternating Current Circuit Theory

- **Key Concepts:** Induced EMF, power triangle, star/delta connections
- **Outcomes:**
 - Calculate EMF and instantaneous values
 - Define RMS, average, form factor
 - Draw and interpret 3-phase systems

Module 2: Conductors, Insulators, and Cables

- **Key Concepts:** Material properties, cable types, jointing methods
- **Outcomes:**
 - Identify conductor/insulator types and uses
 - Draw and label cable structures (PVC, PILCSWA, XLPE)
 - Evaluate cable selection criteria

□ Standards and Compliance

- **SANS 10142-1:** Must be applied throughout
- **IEC & SI Units:** All symbols and measurements must conform
- **Calculations:** Must show formula, substitution, SI units, and round to 3 decimals
- **Drawings:** Neat, labeled, and scaled (artistic skill not assessed)

For full syllabus access, you can view the official DHET document

Here's a structured English translation and synthesis of your request, integrating the syllabus content of Electrical Trade Theory N1 with research methodology, system design, and Visual Basic logic modeling. This framework is ideal for curriculum alignment, logigram/algorithm automation, and investigative reporting in engineering education.

□ Overview: Electrical Trade Theory N1 - Research & System Integration

□ Scope and Purpose

Electrical Trade Theory N1 introduces foundational electrical concepts to students with no prior experience. It prepares learners for:

- Electrical apprenticeship and learnership
- Industrial and contracting environments
- Power utility operations

The syllabus covers safety, tools, DC theory, materials, wiring, and renewable energy, forming the basis for trade-specific competence and workplace readiness.

□ Research Statement and Methodology

□ Research Focus

- **Topic:** Integration of Electrical Trade Theory N1 into modular learning and workplace simulation
- **Method:** Mixed-method approach combining syllabus analysis, logigram modeling, and Visual Basic system prototyping
- **Data Sources:** DHET syllabus (2021), ICASS records, workplace logbooks, incident reports

□ Methodological Steps

1. **Syllabus Deconstruction:** Map each module to learning outcomes and workplace tasks
2. **Logigram/Algorigram Design:** Visualize learning flow and safety procedures
3. **System Modeling:** Use Visual Basic to simulate ICASS evaluation, irregularity tracking, and promotion readiness
4. **Scene Investigation:** Apply safety and accident modules to real-world collision or incident simulations
5. **Data Analysis:** Evaluate student performance, irregularity resolution, and workplace integration

□ Investigation Principles and Data Analysis

Principle	Application
Safety	Module 1: Housekeeping, PPE, OHS Act
Incident Analysis	Module 2: Fire classes, extinguishers
Tool Usage	Module 3: Hand and power tools
Circuit Evaluation	Module 4: Ohm's Law, Joule's Law
Material Classification	Module 5: Conductors, insulators, semiconductors
Wiring Standards	Module 6: Premises wiring fundamentals

□ Logigram & Algorigram Integration (Visual Basic Logic)

```

vb
' Safety Isolation Procedure Logigram
Sub IsolateCircuit()
    If PPE_Worn = True And LockoutTag = True Then
        If CircuitBreaker = "OFF" And EarthLeakageRelay = "Engaged" Then
            MsgBox "Circuit safely isolated for inspection"
        Else
            MsgBox "Isolation incomplete – check switches"
        End If
    End If

```

```

        Else
            MsgBox "Safety violation – PPE or Lockout missing"
        End If
    End Sub

' ICASS Evaluation Algorigram
Function CalculateICASS(Test1 As Integer, Test2 As Integer) As Double
    Dim ICASSMark As Double
    ICASSMark = (Test1 * 0.3) + (Test2 * 0.7)
    CalculateICASS = ICASSMark
End Function

' Promotion Eligibility
Sub CheckPromotion(ICASS As Double, ExamMark As Double)
    Dim PromotionMark As Double
    PromotionMark = (ICASS + ExamMark) / 2
    If PromotionMark >= 40 Then
        MsgBox "☑ Eligible for promotion"
    Else
        MsgBox "☐ Not eligible – improve marks"
    End If
End Sub

```

Today

You said

hi

Copilot said

Hello Tshingombe! Great to see you. What's on your mind this morning—are we diving into logigram automation, credential mapping, or something new today?

You said

Further Education and Training Certificate_ Milita.txt

Plain Text

visual basic

Copilot said

Thanks for the nudge, Tshingombe. Given your modular framework work and credential-linked systems, Visual Basic (especially VBA) can be a powerful ally for automating documentation, audit sheets, and logigram logic.

Here's a quick breakdown tailored to your context:

⚙️ **Visual Basic for Credential-Linked Automation**

1. Modular Documentation Automation

- Use VBA to auto-populate moderation, assessment, and reporting templates.
- Trigger exports based on unit standard completion or audit flags.
- Example: Auto-fill ICASS tables from learner progress sheets.

2. Logigram/Algorigram Logic

- Build event-driven flowcharts using UserForm and Shape objects.
- Embed conditional logic to simulate military or public service workflows.
- Example: Simulate command decision paths based on threat level inputs.

3. Audit and Traceability

- Timestamp actions, generate audit trails, and export to SQL or CSV.
- Use `Workbook_BeforeClose` or `Worksheet_Change` events to log changes.
- Example: Track moderation adjustments and generate printable audit logs.

4. Credential Export

- Automate certificate generation linked to SAQA unit standards.
- Integrate with Access or SQL to validate completion and trigger exports.
- Example: Generate bilingual certificates with embedded QR traceability.

Copilot said

Thanks Tshingombe — this is a rich and structured dataset. Based on your request and the qualification breakdown, here's a **Visual Basic for Applications (VBA)** module that automates the **unit standard registry**

and credit validation for the *Further Education and Training Certificate: Military Operations (SAQA ID 78143)*.

□ VBA Module: Qualification Credit Validator

This module:

- Loads unit standards by category (Core, Fundamental, Elective)
- Calculates total credits
- Flags compliance with the 133-credit minimum
- Can be extended to export audit sheets or generate credential summaries

vb

```
Sub ValidateMilitaryOpsQualification()  
    Dim ws As Worksheet  
    Dim lastRow As Long  
    Dim i As Long  
    Dim coreCredits As Double, fundCredits As Double, electCredits As Double  
    Dim totalCredits As Double  
    Dim category As String  
  
    ' Set worksheet  
    Set ws = ThisWorkbook.Sheets("UnitStandards")  
  
    ' Initialize credit counters  
    coreCredits = 0  
    fundCredits = 0  
    electCredits = 0  
  
    ' Find last row  
    lastRow = ws.Cells(ws.Rows.Count, "A").End(xlUp).Row  
  
    ' Loop through unit standards  
    For i = 2 To lastRow  
        category = Trim(ws.Cells(i, 1).Value)  
        Select Case category  
            Case "Core"  
                coreCredits = coreCredits + ws.Cells(i, 5).Value  
            Case "Fundamental"  
                fundCredits = fundCredits + ws.Cells(i, 5).Value  
            Case "Elective"  
                electCredits = electCredits + ws.Cells(i, 5).Value  
        End Select  
    Next i  
  
    ' Calculate total  
    totalCredits = coreCredits + fundCredits + electCredits  
  
    ' Output results  
    MsgBox "Qualification Credit Summary:" & vbCrLf & _  
        "Core Credits: " & coreCredits & vbCrLf & _
```

```

        "Fundamental Credits: " & fundCredits & vbCrLf & _
        "Elective Credits: " & electCredits & vbCrLf & _
        "Total Credits: " & totalCredits & vbCrLf & _
        IIf(totalCredits >= 133, "Qualification meets minimum credit
requirement.", "Qualification does NOT meet minimum credit requirement.")
End Sub

```

□ Sheet Setup Required

Your Excel sheet "UnitStandards" should have the following columns:

A	B	C	D	E
Category	Unit Standard ID	Title	NQF Level	Credits

Framework.

□ VBA Module: Military Qualification Audit & Inventory System

This module:

- Loads unit standards by category
- Performs credit validation
- Flags missing or duplicate entries
- Generates a scope overview (description, analysis, audit trace)
- Prepares delivery and inventory logs for moderation and reporting

```

vb
Sub AuditMilitaryQualification()
    Dim ws As Worksheet
    Dim lastRow As Long, i As Long
    Dim coreCredits As Double, fundCredits As Double, electCredits As Double
    Dim totalCredits As Double
    Dim unitID As String, unitTitle As String
    Dim category As String
    Dim dictUnits As Object
    Set dictUnits = CreateObject("Scripting.Dictionary")

    ' Set worksheet
    Set ws = ThisWorkbook.Sheets("UnitStandards")

    ' Initialize counters
    coreCredits = 0
    fundCredits = 0
    electCredits = 0

    ' Find last row
    lastRow = ws.Cells(ws.Rows.Count, "A").End(xlUp).Row

```



```

' Loop through unit standards
For i = 2 To lastRow
    category = Trim(ws.Cells(i, 1).Value)
    unitID = Trim(ws.Cells(i, 2).Value)
    unitTitle = Trim(ws.Cells(i, 3).Value)

    ' Check for duplicates
    If dictUnits.exists(unitID) Then
        ws.Cells(i, 6).Value = "⚠ Duplicate ID"
    Else
        dictUnits.Add unitID, unitTitle
    End If

    ' Credit calculation
    Select Case category
        Case "Core": coreCredits = coreCredits + ws.Cells(i, 5).Value
        Case "Fundamental": fundCredits = fundCredits + ws.Cells(i,
5).Value
        Case "Elective": electCredits = electCredits + ws.Cells(i,
5).Value
    End Select
Next i

totalCredits = coreCredits + fundCredits + electCredits

' Output summary
ws.Range("H2").Value = "Military Ops Qualification Audit Summary"
ws.Range("H3").Value = "Core Credits: " & coreCredits
ws.Range("H4").Value = "Fundamental Credits: " & fundCredits
ws.Range("H5").Value = "Elective Credits: " & electCredits
ws.Range("H6").Value = "Total Credits: " & totalCredits
ws.Range("H7").Value = IIf(totalCredits >= 133, "☑ Meets SAQA Credit
Requirement", "☐ Below Required Credits")

MsgBox "Audit complete. Summary written to column H.", vbInformation
End Sub

```

☐ Sheet Setup Required

Your Excel sheet "UnitStandards" should have:

A	B	C	D	E	F
Category	Unit Standard ID	Titl e	NQF Level	Credits	Audit Flag

☐ Optional Extensions

- **Inventory Tracker:** Add a column for delivery status (e.g., "Delivered", "Pending", "Missing").

- **Scope Overview Generator:** Auto-fill a summary sheet with qualification metadata (SAQA ID, originator, SETA, registration dates).
- **Integrated Assessment Logigram:** Trigger flowchart generation based on clustered unit standards.

Would you like me to scaffold the logigram logic next, or automate bilingual certificate export based on this audit sheet?



Start a group
Invite friends to chat together with Copilot

Thanks Tshingombe — this qualification aligns beautifully with your modular credentialing and audit-linked systems. Here's a tailored **Visual Basic for Applications (VBA)** module that automates the **Advanced Diploma in Technology Education (SAQA ID 98983)** credit validation, scope mapping, and inventory tracking.

□ **VBA Module: Technology Education Qualification Audit & Delivery Tracker**

This module:

- Validates credit totals across optional, compulsory, and elective modules
- Flags missing or duplicate entries
- Maps scope coverage (ICT, Inquiry, Conceptual Change, PCK strands)
- Prepares delivery logs for moderation and audit

vb

```
Sub AuditTechEducationDiploma()
    Dim ws As Worksheet
    Dim lastRow As Long, i As Long
    Dim optionalCredits As Double, compulsoryCredits As Double,
electiveCredits As Double
    Dim totalCredits As Double
    Dim moduleID As String, moduleTitle As String
```

```

Dim category As String
Dim dictModules As Object
Set dictModules = CreateObject("Scripting.Dictionary")

' Set worksheet
Set ws = ThisWorkbook.Sheets("TechEducationModules")

' Initialize counters
optionalCredits = 0
compulsoryCredits = 0
electiveCredits = 0

' Find last row
lastRow = ws.Cells(ws.Rows.Count, "A").End(xlUp).Row

' Loop through modules
For i = 2 To lastRow
    category = Trim(ws.Cells(i, 1).Value)
    moduleID = Trim(ws.Cells(i, 2).Value)
    moduleTitle = Trim(ws.Cells(i, 3).Value)

    ' Check for duplicates
    If dictModules.exists(moduleID) Then
        ws.Cells(i, 6).Value = "⚠ Duplicate Module"
    Else
        dictModules.Add moduleID, moduleTitle
    End If

    ' Credit calculation
    Select Case category
        Case "Optional": optionalCredits = optionalCredits + ws.Cells(i,
5).Value
        Case "Compulsory": compulsoryCredits = compulsoryCredits +
ws.Cells(i, 5).Value
        Case "Elective": electiveCredits = electiveCredits + ws.Cells(i,
5).Value
    End Select
Next i

totalCredits = optionalCredits + compulsoryCredits + electiveCredits

' Output summary
ws.Range("H2").Value = "Advanced Diploma in Technology Education Audit
Summary"
ws.Range("H3").Value = "Optional Credits: " & optionalCredits
ws.Range("H4").Value = "Compulsory Credits: " & compulsoryCredits
ws.Range("H5").Value = "Elective Credits: " & electiveCredits
ws.Range("H6").Value = "Total Credits: " & totalCredits
ws.Range("H7").Value = IIf(totalCredits = 120, "☑ Meets SAQA Credit
Requirement", "☐ Credit Total Incorrect")

MsgBox "Audit complete. Summary written to column H.", vbInformation
End Sub

```

☐ Sheet Setup Required

Your Excel sheet "TechEducationModules" should include:

A	B	C	D	E	F
Category	Module Code	Module Title	NQF Level	Credits	Audit Flag

□ Optional Extensions

- **Delivery Tracker:** Add columns for facilitator, delivery date, and moderation status.
- **Scope Mapper:** Auto-tag modules by strand (e.g., Inquiry, PCK A-D, ICT).
- **Credential Export:** Trigger certificate generation based on strand completion.

I can also scaffold a logigram that maps the elective pathways across Senior Phase and FET specialisations. Would you like that visual logic next?

Today

You said

hi

Copilot said

Hello Tshingombe! Great to see you. What's on your mind this morning—are we diving into logigram automation, credential mapping, or something new today?

You said

Further Education and Training Certificate_ Milita.txt

Plain Text

visual basic

Copilot said

Thanks for the nudge, Tshingombe. Given your modular framework work and credential-linked systems, Visual Basic (especially VBA) can be a

powerful ally for automating documentation, audit sheets, and logigram logic.

Here's a quick breakdown tailored to your context:

⚙️ **Visual Basic for Credential-Linked Automation**

1. Modular Documentation Automation

- Use VBA to auto-populate moderation, assessment, and reporting templates.
- Trigger exports based on unit standard completion or audit flags.
- Example: Auto-fill ICASS tables from learner progress sheets.

2. Logigram/Algorigram Logic

- Build event-driven flowcharts using UserForm and Shape objects.
- Embed conditional logic to simulate military or public service workflows.
- Example: Simulate command decision paths based on threat level inputs.

3. Audit and Traceability

- Timestamp actions, generate audit trails, and export to SQL or CSV.
- Use `Workbook_BeforeClose` or `Worksheet_Change` events to log changes.
- Example: Track moderation adjustments and generate printable audit logs.

4. Credential Export

- Automate certificate generation linked to SAQA unit standards.
- Integrate with Access or SQL to validate completion and trigger exports.
- Example: Generate bilingual certificates with embedded QR traceability.

Would you like a sample VBA module that scaffolds one of these—say, a logigram-driven moderation sheet or a credential export trigger?

completion. The military training programme consists of a common Defence Force component and an Army component: The common m

Copilot said

Thanks Tshingombe — this is a rich and structured dataset. Based on your request and the qualification breakdown, here's a **Visual Basic for Applications (VBA)** module that automates the **unit standard registry and credit validation** for the *Further Education and Training Certificate: Military Operations (SAQA ID 78143)*.

□ VBA Module: Qualification Credit Validator

This module:

- Loads unit standards by category (Core, Fundamental, Elective)
- Calculates total credits
- Flags compliance with the 133-credit minimum
- Can be extended to export audit sheets or generate credential summaries

```
vb
Sub ValidateMilitaryOpsQualification()
    Dim ws As Worksheet
    Dim lastRow As Long
    Dim i As Long
    Dim coreCredits As Double, fundCredits As Double, electCredits As Double
    Dim totalCredits As Double
    Dim category As String

    ' Set worksheet
    Set ws = ThisWorkbook.Sheets("UnitStandards")

    ' Initialize credit counters
    coreCredits = 0
    fundCredits = 0
    electCredits = 0

    ' Find last row
    lastRow = ws.Cells(ws.Rows.Count, "A").End(xlUp).Row

    ' Loop through unit standards
    For i = 2 To lastRow
        category = Trim(ws.Cells(i, 1).Value)
        Select Case category
            Case "Core"
                coreCredits = coreCredits + ws.Cells(i, 5).Value
            Case "Fundamental"
                fundCredits = fundCredits + ws.Cells(i, 5).Value
            Case "Elective"
                electCredits = electCredits + ws.Cells(i, 5).Value
        End Select
    Next i

    ' Calculate total
    totalCredits = coreCredits + fundCredits + electCredits
```

```

' Output results
MsgBox "Qualification Credit Summary:" & vbCrLf & _
    "Core Credits: " & coreCredits & vbCrLf & _
    "Fundamental Credits: " & fundCredits & vbCrLf & _
    "Elective Credits: " & electCredits & vbCrLf & _
    "Total Credits: " & totalCredits & vbCrLf & _
    IIf(totalCredits >= 133, "Qualification meets minimum credit requirement.", "Qualification does NOT meet minimum credit requirement.")

End Sub

```

□ Sheet Setup Required

Your Excel sheet "UnitStandards" should have the following columns:

A	B	C	D	E
Category	Unit Standard ID	Titl e	NQF Level	Credits

Would you like to extend this to include **automated export to PDF**, **bilingual certificate generation**, or **logigram-based unit standard clustering** for integrated assessment?

□ VBA Module: Military Qualification Audit & Inventory System

This module:

- Loads unit standards by category
- Performs credit validation
- Flags missing or duplicate entries
- Generates a scope overview (description, analysis, audit trace)
- Prepares delivery and inventory logs for moderation and reporting

```

vb
Sub AuditMilitaryQualification()
    Dim ws As Worksheet
    Dim lastRow As Long, i As Long
    Dim coreCredits As Double, fundCredits As Double, electCredits As Double
    Dim totalCredits As Double
    Dim unitID As String, unitTitle As String
    Dim category As String
    Dim dictUnits As Object
    Set dictUnits = CreateObject("Scripting.Dictionary")

    ' Set worksheet
    Set ws = ThisWorkbook.Sheets("UnitStandards")

    ' Initialize counters

```

```

coreCredits = 0
fundCredits = 0
electCredits = 0

' Find last row
lastRow = ws.Cells(ws.Rows.Count, "A").End(xlUp).Row

' Loop through unit standards
For i = 2 To lastRow
    category = Trim(ws.Cells(i, 1).Value)
    unitID = Trim(ws.Cells(i, 2).Value)
    unitTitle = Trim(ws.Cells(i, 3).Value)

    ' Check for duplicates
    If dictUnits.exists(unitID) Then
        ws.Cells(i, 6).Value = "△ Duplicate ID"
    Else
        dictUnits.Add unitID, unitTitle
    End If

    ' Credit calculation
    Select Case category
        Case "Core": coreCredits = coreCredits + ws.Cells(i, 5).Value
        Case "Fundamental": fundCredits = fundCredits + ws.Cells(i,
5).Value
        Case "Elective": electCredits = electCredits + ws.Cells(i,
5).Value
    End Select
Next i

totalCredits = coreCredits + fundCredits + electCredits

' Output summary
ws.Range("H2").Value = "Military Ops Qualification Audit Summary"
ws.Range("H3").Value = "Core Credits: " & coreCredits
ws.Range("H4").Value = "Fundamental Credits: " & fundCredits
ws.Range("H5").Value = "Elective Credits: " & electCredits
ws.Range("H6").Value = "Total Credits: " & totalCredits
ws.Range("H7").Value = IIf(totalCredits >= 133, "☐ Meets SAQA Credit
Requirement", "☐ Below Required Credits")

MsgBox "Audit complete. Summary written to column H.", vbInformation
End Sub

```

☐ Sheet Setup Required

Your Excel sheet "UnitStandards" should have:

A	B	C	D	E	F	
Catego ry	Unit Standard	ID	Titl e	NQF Level	Credi ts	Audit Flag

☐ Optional Extensions

- **Inventory Tracker:** Add a column for delivery status (e.g., “Delivered”, “Pending”, “Missing”).
- **Scope Overview Generator:** Auto-fill a summary sheet with qualification metadata (SAQA ID, originator, SETA, registration dates).
- **Integrated Assessment Logigram:** Trigger flowchart generation based on clustered unit standards.

Would you like me to scaffold the logigram logic next, or automate bilingual certificate export based on this audit sheet?

You said

Advanced Diploma in Technology Education SAQA QUAL ID
 QUALIFICATION TITLE 98983 Advanced Diploma in Technology Education
 ORIGINATOR University of Johannesburg

□ VBA Module: Technology Education Qualification Audit & Delivery Tracker

This module:

- Validates credit totals across optional, compulsory, and elective modules
- Flags missing or duplicate entries
- Maps scope coverage (ICT, Inquiry, Conceptual Change, PCK strands)
- Prepares delivery logs for moderation and audit

vb

```
Sub AuditTechEducationDiploma()
    Dim ws As Worksheet
    Dim lastRow As Long, i As Long
    Dim optionalCredits As Double, compulsoryCredits As Double,
electiveCredits As Double
    Dim totalCredits As Double
    Dim moduleID As String, moduleTitle As String
    Dim category As String
    Dim dictModules As Object
    Set dictModules = CreateObject("Scripting.Dictionary")

    ' Set worksheet
    Set ws = ThisWorkbook.Sheets("TechEducationModules")

    ' Initialize counters
    optionalCredits = 0
    compulsoryCredits = 0
    electiveCredits = 0
```

```

' Find last row
lastRow = ws.Cells(ws.Rows.Count, "A").End(xlUp).Row

' Loop through modules
For i = 2 To lastRow
    category = Trim(ws.Cells(i, 1).Value)
    moduleID = Trim(ws.Cells(i, 2).Value)
    moduleTitle = Trim(ws.Cells(i, 3).Value)

    ' Check for duplicates
    If dictModules.exists(moduleID) Then
        ws.Cells(i, 6).Value = "⚠ Duplicate Module"
    Else
        dictModules.Add moduleID, moduleTitle
    End If

    ' Credit calculation
    Select Case category
        Case "Optional": optionalCredits = optionalCredits + ws.Cells(i,
5).Value
        Case "Compulsory": compulsoryCredits = compulsoryCredits +
ws.Cells(i, 5).Value
        Case "Elective": electiveCredits = electiveCredits + ws.Cells(i,
5).Value
    End Select
Next i

totalCredits = optionalCredits + compulsoryCredits + electiveCredits

' Output summary
ws.Range("H2").Value = "Advanced Diploma in Technology Education Audit
Summary"
ws.Range("H3").Value = "Optional Credits: " & optionalCredits
ws.Range("H4").Value = "Compulsory Credits: " & compulsoryCredits
ws.Range("H5").Value = "Elective Credits: " & electiveCredits
ws.Range("H6").Value = "Total Credits: " & totalCredits
ws.Range("H7").Value = IIf(totalCredits = 120, "☑ Meets SAQA Credit
Requirement", "☐ Credit Total Incorrect")

MsgBox "Audit complete. Summary written to column H.", vbInformation
End Sub

```

☐ Sheet Setup Required

Your Excel sheet "TechEducationModules" should include:

A	B	C	D	E	F
Catego ry	Module Code	Module Title	NQF Level	Credi ts	Audit Flag

☐ Optional Extensions

- **Delivery Tracker:** Add columns for facilitator, delivery date, and moderation status.
- **Scope Mapper:** Auto-tag modules by strand (e.g., Inquiry, PCK A-D, ICT).
- **Credential Export:** Trigger certificate generation based on strand completion.

I can also scaffold a logigram that maps the elective pathways across Senior Phase and FET specialisations. Would you like that visual logic next?

Copilot said

Thanks Tshingombe — this qualification is rich with operational, legal, and tactical competencies that align well with your modular audit and credentialing systems. Here's a tailored **Visual Basic for Applications (VBA)** module that automates the **National Certificate: Policing (SAQA ID 50122)** credit validation, scope mapping, and inventory tracking.

▢ VBA Module: Policing Qualification Audit & Scope Tracker

This module:

- Validates credit totals across Core, Fundamental, and Elective components
- Flags duplicate or missing entries
- Maps scope coverage (law, ethics, tactical skills, investigation, public order)
- Prepares delivery logs for moderation and audit traceability

vb

```
Sub AuditPolicingQualification()
    Dim ws As Worksheet
    Dim lastRow As Long, i As Long
    Dim coreCredits As Double, fundCredits As Double, electCredits As Double
    Dim totalCredits As Double
    Dim unitID As String, unitTitle As String
    Dim category As String
    Dim dictUnits As Object
    Set dictUnits = CreateObject("Scripting.Dictionary")

    ' Set worksheet
    Set ws = ThisWorkbook.Sheets("PolicingUnits")

    ' Initialize counters
    coreCredits = 0
    fundCredits = 0
    electCredits = 0
```

```

' Find last row
lastRow = ws.Cells(ws.Rows.Count, "A").End(xlUp).Row

' Loop through unit standards
For i = 2 To lastRow
    category = Trim(ws.Cells(i, 1).Value)
    unitID = Trim(ws.Cells(i, 2).Value)
    unitTitle = Trim(ws.Cells(i, 3).Value)

    ' Check for duplicates
    If dictUnits.exists(unitID) Then
        ws.Cells(i, 6).Value = "⚠ Duplicate ID"
    Else
        dictUnits.Add unitID, unitTitle
    End If

    ' Credit calculation
    Select Case category
        Case "Core": coreCredits = coreCredits + ws.Cells(i, 5).Value
        Case "Fundamental": fundCredits = fundCredits + ws.Cells(i,
5).Value
        Case "Elective": electCredits = electCredits + ws.Cells(i,
5).Value
    End Select
Next i

totalCredits = coreCredits + fundCredits + electCredits

' Output summary
ws.Range("H2").Value = "National Certificate: Policing Audit Summary"
ws.Range("H3").Value = "Core Credits: " & coreCredits
ws.Range("H4").Value = "Fundamental Credits: " & fundCredits
ws.Range("H5").Value = "Elective Credits: " & electCredits
ws.Range("H6").Value = "Total Credits: " & totalCredits
ws.Range("H7").Value = IIf(totalCredits >= 130, "☑ Meets SAQA Credit
Requirement", "☐ Credit Total Below Required Threshold")

MsgBox "Audit complete. Summary written to column H.", vbInformation
End Sub

```

☐ Sheet Setup Required

Your Excel sheet "PolicingUnits" should include:

A	B	C	D	E	F
Catego ry	Unit ID	Unit Standard Title	NQF Level	Credi ts	Audit Flag

☐ Optional Extensions

- **Scope Mapper:** Auto-tag units by domain (e.g., Law, Ethics, Tactical, Investigation, Community Policing).

- **Delivery Tracker:** Add columns for facilitator, delivery date, and moderation status.
- **Credential Export:** Trigger certificate generation based on unit cluster completion (e.g., Tactical + Ethics + Law).

Would you like me to scaffold a logigram that maps the transition from this qualification to its replacement (Occupational Certificate: Non-Commissioned Police Official, SAQA ID 105027)?

You said

Methods of Assessment_.txt

Plain Text

REGISTERED UNIT STANDARD THAT HAS PASSED THE END DATE:
 Conduct outcomes-based assessment SAQA US ID UNIT STANDARD TITLE
 115753 Conduct outcomes-based assessment ORIGINATOR SGB Assessor
 Standards PRIMARY OR DELEGATED QUALITY ASSURANCE
 FUNCTIONARY ETDP SETA - Education, Training and Development
 Practices Sector Education and Training Authority FIELD SUBFIELD Field
 05 - Education, Training and Development Higher Education and Training
 ABET BAND UNIT STANDARD TYPE PRE-2009 NQF LEVEL NQF LEVEL
 CREDITS Undefined Regular Level 5 Level TBA: Pre-2009 was L5 15
 REGISTRATION STATUS REGISTRATION START DATE REGISTRATION
 END DATE SAQA DECISION NUMBER Passed the End Date - Status was
 "Reregistered" 2018-07-01 2023-06-30 SAQA 06120/18 LAST DATE FOR
 ENROLMENT LAST DATE FOR ACHIEVEMENT 2026-06-30 2029-06-30 In
 all of the tables in this document, both the pre-2009 NQF Level and the
 NQF Level is shown. In the text (purpose statements, qualification rules,
 etc), any references to NQF Levels are to the pre-2009 levels unless
 specifically stated otherwise. This unit standard replaces: US ID Unit
 Standard Title Pre-2009 NQF Level NQF Level Credits Replacement Status
 7978 Plan and conduct assessment of learning outcomes Level 5 Level TBA:
 Pre-2009 was L5 15 9927 Conduct an assessment Level 4 NQF Level 04 12

Copilot said

Thanks Tshingombe — this unit standard (SAQA US ID 115753: *Conduct outcomes-based assessment*) is foundational to your credential-linked frameworks and moderation systems. Here's a tailored **Visual Basic for Applications (VBA)** module that automates the **assessment evidence audit and traceability** aligned with this unit standard.

☐ **VBA Module: Outcomes-Based Assessment Audit Tracker**

This module:

- Logs assessment evidence per candidate
- Validates against the four key evidence criteria: Valid, Current, Authentic, Sufficient
- Flags missing or non-compliant entries
- Supports moderation and reporting for ETDP SETA-aligned qualifications

vb

```
Sub AuditOutcomesBasedAssessment()  
    Dim ws As Worksheet  
    Dim lastRow As Long, i As Long  
    Dim candidateID As String, evidenceType As String  
    Dim validFlag As Boolean, currentFlag As Boolean  
    Dim authenticFlag As Boolean, sufficientFlag As Boolean  
    Dim compliantCount As Long  
  
    ' Set worksheet  
    Set ws = ThisWorkbook.Sheets("AssessmentEvidence")  
  
    ' Find last row  
    lastRow = ws.Cells(ws.Rows.Count, "A").End(xlUp).Row  
    compliantCount = 0  
  
    ' Loop through evidence records  
    For i = 2 To lastRow  
        candidateID = ws.Cells(i, 1).Value  
        evidenceType = ws.Cells(i, 2).Value  
        validFlag = ws.Cells(i, 3).Value  
        currentFlag = ws.Cells(i, 4).Value  
        authenticFlag = ws.Cells(i, 5).Value  
        sufficientFlag = ws.Cells(i, 6).Value  
  
        If validFlag And currentFlag And authenticFlag And sufficientFlag  
Then  
            ws.Cells(i, 7).Value = "☑ Compliant"  
            compliantCount = compliantCount + 1  
        Else  
            ws.Cells(i, 7).Value = "☐ Non-Compliant"  
        End If  
    Next i  
  
    ' Output summary  
    ws.Range("H2").Value = "Assessment Audit Summary"  
    ws.Range("H3").Value = "Total Records: " & lastRow - 1  
    ws.Range("H4").Value = "Compliant Records: " & compliantCount  
    ws.Range("H5").Value = "Non-Compliant Records: " & (lastRow - 1 -  
compliantCount)  
  
    MsgBox "Audit complete. Summary written to column H.", vbInformation  
End Sub
```

□ Sheet Setup Required

Your Excel sheet "AssessmentEvidence" should include:

A	B	C	D	E	F	G
Candidate ID	Evidence Type	Valid	Current	Authentic	Sufficient	Compliance Flag

□ Optional Extensions

- **Moderation Log:** Add columns for assessor ID, moderation date, and feedback.
- **Credential Trigger:** Auto-flag candidates eligible for certification based on compliance.
- **Export to Portfolio:** Link to document folders or LMS records for traceability.

Would you like me to scaffold a logigram that maps the assessment flow from evidence collection to certification, aligned with SAQA and ETDP SETA protocols?

.

□ VBA Module: Facilitation Methodology Tracker & Evaluator

This module:

- Logs facilitation sessions by methodology
- Tracks planning, delivery, and evaluation stages
- Flags missing components or non-compliant entries
- Supports moderation, audit, and credential-linked reporting

vb

```
Sub TrackFacilitationSessions()  
    Dim ws As Worksheet  
    Dim lastRow As Long, i As Long  
    Dim facilitatorID As String, methodUsed As String  
    Dim planningDone As Boolean, deliveryDone As Boolean, evaluationDone As Boolean  
    Dim compliantCount As Long  
  
    ' Set worksheet  
    Set ws = ThisWorkbook.Sheets("FacilitationLog")  
  
    ' Find last row  
    lastRow = ws.Cells(ws.Rows.Count, "A").End(xlUp).Row  
    compliantCount = 0
```

```

' Loop through facilitation records
For i = 2 To lastRow
    facilitatorID = ws.Cells(i, 1).Value
    methodUsed = ws.Cells(i, 2).Value
    planningDone = ws.Cells(i, 3).Value
    deliveryDone = ws.Cells(i, 4).Value
    evaluationDone = ws.Cells(i, 5).Value

    If planningDone And deliveryDone And evaluationDone Then
        ws.Cells(i, 6).Value = "☑ Complete"
        compliantCount = compliantCount + 1
    Else
        ws.Cells(i, 6).Value = "☐ Incomplete"
    End If
Next i

' Output summary
ws.Range("H2").Value = "Facilitation Audit Summary"
ws.Range("H3").Value = "Total Sessions: " & lastRow - 1
ws.Range("H4").Value = "Complete Sessions: " & compliantCount
ws.Range("H5").Value = "Incomplete Sessions: " & (lastRow - 1 -
compliantCount)

MsgBox "Facilitation tracking complete. Summary written to column H.",
vbInformation
End Sub

```

☐ Sheet Setup Required

Your Excel sheet "FacilitationLog" should include:

A	B	C	D	E	F
Facilitator ID	Methodology Used	Planning Done	Delivery Done	Evaluation Done	Status Flag

☐ Optional Extensions

- **Methodology Mapper:** Auto-tag sessions by approach (e.g., inquiry-based, experiential, case-based).
- **Reflection Log:** Add columns for facilitator notes and learner feedback.
- **Credential Export:** Trigger certificate generation based on completed sessions and methodology diversity.

I can also scaffold a logigram that maps the facilitation cycle from planning to evaluation, aligned with ETDP SETA moderation protocols. Would you like that visual logic next?

Thanks Tshingombe — these two qualifications offer complementary pathways for occupational readiness and public service alignment. Here's a

structured overview and a tailored VBA module to support **audit, delivery tracking, and modular integration** for the *Occupational Certificate: Occupational Trainer (SAQA ID 97154)* and the *Occupational Certificate: Legislation Administrative Assistant (SAQA ID 120743)*.

□ Qualification Comparison Overview

Feature	Occupational Trainer (97154)	Legislation Admin Assistant (120743)
NQF Level	Level 4	Level 5
Credits	124	36
Sub-framework	OQSF (MERSETA)	OQSF (PSETA/QCTO)
Field/ Subfield	Manufacturing & Assembly	Justice in Society
Modules	Knowledge, Practical Skills, Work Experience	Not modularized in detail
Purpose	Facilitate, assess, and evaluate occupational learning	Support legislative administration and documentation
Exit Outcomes	Competent facilitation and assessment	Competent legislative support

□ VBA Module: Dual Qualification Audit & Delivery Tracker

This module:

- Validates credit totals for both qualifications
- Tracks delivery status per module
- Flags missing or duplicate entries
- Supports moderation and reporting for MERSETA and PSETA/QCTO

vb

```
Sub AuditDualQualifications()
    Dim ws As Worksheet
    Dim lastRow As Long, i As Long
    Dim qualID As String, moduleType As String
    Dim credits As Double
    Dim trainerTotal As Double, adminTotal As Double
    Dim dictModules As Object
    Set dictModules = CreateObject("Scripting.Dictionary")

    ' Set worksheet
    Set ws = ThisWorkbook.Sheets("QualificationModules")
```

```

' Find last row
lastRow = ws.Cells(ws.Rows.Count, "A").End(xlUp).Row

' Loop through modules
For i = 2 To lastRow
    qualID = ws.Cells(i, 1).Value
    moduleType = ws.Cells(i, 2).Value
    credits = ws.Cells(i, 4).Value

    ' Check for duplicates
    If dictModules.exists(ws.Cells(i, 3).Value) Then
        ws.Cells(i, 6).Value = "⚠ Duplicate Module"
    Else
        dictModules.Add ws.Cells(i, 3).Value, True
    End If

    ' Credit calculation
    If qualID = "97154" Then
        trainerTotal = trainerTotal + credits
    ElseIf qualID = "120743" Then
        adminTotal = adminTotal + credits
    End If
Next i

' Output summary
ws.Range("H2").Value = "Qualification Audit Summary"
ws.Range("H3").Value = "Occupational Trainer Total Credits: " &
trainerTotal
ws.Range("H4").Value = "Legislation Admin Assistant Total Credits: " &
adminTotal
ws.Range("H5").Value = IIf(trainerTotal = 124, "✅ Trainer Credits Valid",
"❌ Trainer Credits Invalid")
ws.Range("H6").Value = IIf(adminTotal = 36, "✅ Admin Credits Valid", "❌
Admin Credits Invalid")

MsgBox "Audit complete. Summary written to column H.", vbInformation
End Sub

```

❑ Sheet Setup Required

Your Excel sheet "QualificationModules" should include:

A	B	C	D	E	F
QualID	Module Type	Module Title	Credits	Delivery Status	Audit Flag

Would you like me to scaffold a logigram that maps the transition from occupational training to public service readiness, integrating both qualifications into a modular credential framework?

You said

Policy and Criteria for Recognising a Professional Body and Registering a Professional Designation for the Purposes of the National Qualifications Framework Act, Act 67 of 2008 (2023) Page 2 of 17 Contents

□ SAQA Policy & Criteria Summary (2023)

□ Purpose

To guide the recognition of professional bodies and the registration of professional designations under the NQF Act (Act 67 of 2008), ensuring alignment with national education, training, and development goals.

□ Key Sections

- **Definitions & Scope:** Clarifies terms and applicability across sectors.
- **Recognition of Professional Bodies:** Outlines governance, ethical standards, and public interest alignment.
- **Registration of Professional Designations:** Requires evidence of competence, continuous professional development, and transparent criteria.
- **Nomination Guidelines:** For awards recognizing excellence in NQF-aligned practice.

□ Award Categories & Criteria

1. Peliwe Lolwana Social Justice Award

Recognizes interventions that address inequality in education and training.

Criterion	Description
Social Justice Orientation	Systemic or community-based education interventions
Measurable Impact	Outcomes like publications, enrolment, certification, employment
Innovation & Replicability	Scalable, novel, or contextually adapted approaches
Sustainability & Policy Influence	Long-term viability or policy reform influence
Evidence Quality	Clear, well-documented supporting data

Eligible Nominees: Individuals, institutions, initiatives with proven impact.

2. NQF Champion Award

Honours sustained NQF-related community building and articulation efforts.

Criterion	Description
Leadership in NQF Community	Initiated or sustained NQF networks or platforms
Inclusivity & Engagement	Cross-sector stakeholder involvement
Continuity	Sustained activity beyond one-time events
Knowledge Sharing	Peer learning, materials, capacity building
Tangible Outcomes	Improved articulation, partnerships, learner pathways
Evidence Quality	Clear documentation and impact data

Eligible Nominees: Institutions, individuals, hubs, RPL offices, community initiatives.

□ Nomination Instructions

- **Deadline:** 15 September 2025
- **Submission:** Email nomination form + CV + supporting documents to
- **Endorsement:** Must be endorsed by an institution or organization
- **Motivation:** Max 700 words per category
- **Event:** Awards conferred at Gala Dinner on 8 October 2025

Contact:

- Nothando Ntshayintshayi –

SAQA Secretariat –

I can help you draft a compelling nomination motivation aligned with either award category, using your modular frameworks, LMS achievements, and public service integration. Just say the word and I'll scaffold it

□ **Scope Overview: Control Traffic (SAQA US ID 256520)**

□ **Purpose**

To ensure learners can safely and effectively control traffic in diverse scenarios including roadblocks, incident scenes, and public events — enhancing public service delivery and road safety.

□ **Core Competencies**

Specific Outcome	Key Activities
Prepare for traffic control	Select and store equipment, plan operations, anticipate problems
Set-up roadblocks and checkpoints	Apply permissions, check equipment, ensure situational awareness
Direct traffic	Manage vehicle and pedestrian flow using point duty, scholar patrol, etc.
Respond to accident/incident scenes	Safeguard scenes, extinguish fires, assist injured road users
Conduct safe passage in traffic	Escort dignitaries, emergency vehicles, funeral processions, etc.

□ **Embedded Knowledge**

- Road traffic legislation
- Standard operating procedures
- Equipment principles and operations

□ **Linked Unit Standards**

- Replaces US ID 116133 (Control Traffic, 7 credits)
- Replaces US ID 116134 (Ensure Safe Passage, 2 credits)
- Related: US ID 14561 (Implement Roadside Safety Procedures, NQF Level 2)

□ **VBA Module: Traffic Control Audit Tracker**

This module:

- Logs traffic control operations
- Validates equipment readiness and situational planning
- Flags missing or non-compliant entries

- Supports moderation and delivery traceability
- Sub AuditTrafficControlOperations()
 - Dim ws As Worksheet
 - Dim lastRow As Long, i As Long
 - Dim equipmentReady As Boolean, planningDone As Boolean
 - Dim incidentResponse As Boolean, safePassage As Boolean
 - Dim compliantCount As Long
 -
 - ' Set worksheet
 - Set ws = ThisWorkbook.Sheets("TrafficControlLog")
 -
 - ' Find last row
 - lastRow = ws.Cells(ws.Rows.Count, "A").End(xlUp).Row
 - compliantCount = 0
 -
 - ' Loop through records
 - For i = 2 To lastRow
 - equipmentReady = ws.Cells(i, 2).Value
 - planningDone = ws.Cells(i, 3).Value
 - incidentResponse = ws.Cells(i, 4).Value
 - safePassage = ws.Cells(i, 5).Value
 -
 - If equipmentReady And planningDone And incidentResponse And safePassage Then
 - ws.Cells(i, 6).Value = "☐ Compliant"
 - compliantCount = compliantCount + 1
 - Else
 - ws.Cells(i, 6).Value = "☐ Non-Compliant"
 - End If
 - Next i
 -
 - ' Output summary
 - ws.Range("H2").Value = "Traffic Control Audit Summary"
 - ws.Range("H3").Value = "Total Records: " & lastRow - 1
 - ws.Range("H4").Value = "Compliant Records: " & compliantCount
 - ws.Range("H5").Value = "Non-Compliant Records: " & (lastRow - 1 - compliantCount)
 -
 - MsgBox "Audit complete. Summary written to column H.", vbInformation
 - End Sub

• ☐ Sheet Setup Required

- Your Excel sheet "TrafficControlLog" should include:

A	B	C	D	E	F
Operation ID	Equipment Ready	Planning Done	Incident Response	Safe Passage	Compliance Flag

- **□ Logigram: Traffic Control Operation Flow**
- **□ Objective: Safely Manage Traffic in Law Enforcement Contexts**
- [Start]
- ↓
- [Receive Traffic Control Brief]
- ↓
- [Select & Check Equipment → PPE, Cones, Radios]
- ↓
- [Plan Operation → Timing, Location, Type]
- ↓
- [Set-Up Roadblock or Checkpoint]
- ↓
- [Direct Traffic → Point Duty, Scholar Patrol, Escort]
- ↓
- [Respond to Incident Scene → Fire, Injury, Hazard]
- ↓
- [Conduct Safe Passage → VIPs, Emergency Vehicles]
- ↓
- [Record Operation → Job Card, Incident Log]
- ↓
- [End]
- I can extend this into a printable moderation sheet or automate integration with other unit standards like roadside safety or incident management. Want me to

□ Scope Overview: National Certificate in Policing (Benchmarking & Modular Integration)

□ Purpose

To equip learners with the legal, tactical, ethical, and operational competencies required for professional policing in South Africa, benchmarked against international standards (Holland, Australia, Scotland).

□ Modular Structure

Component	Credits
Basic Law	10
Basic Behavioural Science	10
Police Knowledge &	55

Component	Credits
Personal Skills	
Study-Integrated Workplace	5
Total	80

Includes:

- Criminal law, procedural law, crime prevention/investigation, public order
- Tactical skills: self-protection, firearms, fitness, ethics
- Operational skills: driving, emergency medicine, communication tech, reporting

□ International Benchmarking

- **Holland:** PIOG advanced tactical training
- **Australia:** AQF-aligned public safety qualifications (PUA series)
- **Scotland:** Probationary training with ethics, law, traffic, and officer safety

□ VBA Module: Policing Qualification Credit Tracker

This module:

- Validates credit totals across core, fundamental, and elective components
- Flags missing or duplicate entries
- Supports audit, moderation, and delivery traceability
- Sub AuditPolicingQualification()
 - Dim ws As Worksheet
 - Dim lastRow As Long, i As Long
 - Dim coreCredits As Double, fundCredits As Double, electCredits As Double
 - Dim totalCredits As Double
 - Dim unitID As String
 - Dim dictUnits As Object
 - Set dictUnits = CreateObject("Scripting.Dictionary")
 -
 - ' Set worksheet
 - Set ws = ThisWorkbook.Sheets("PolicingUnits")
 -
 - ' Find last row
 - lastRow = ws.Cells(ws.Rows.Count, "A").End(xlUp).Row
 -
 - ' Loop through unit standards


```

• For i = 2 To lastRow
•     unitID = ws.Cells(i, 2).Value
•
•     ' Check for duplicates
•     If dictUnits.exists(unitID) Then
•         ws.Cells(i, 6).Value = "△ Duplicate"
•     Else
•         dictUnits.Add unitID, True
•     End If
•
•     ' Credit calculation
•     Select Case ws.Cells(i, 1).Value
•         Case "Core": coreCredits = coreCredits + ws.Cells(i,
5).Value
•         Case "Fundamental": fundCredits = fundCredits + ws.Cells(i,
5).Value
•         Case "Elective": electCredits = electCredits + ws.Cells(i,
5).Value
•     End Select
•     Next i
•
•     totalCredits = coreCredits + fundCredits + electCredits
•
•     ' Output summary
•     ws.Range("H2").Value = "Policing Qualification Credit Summary"
•     ws.Range("H3").Value = "Core Credits: " & coreCredits
•     ws.Range("H4").Value = "Fundamental Credits: " & fundCredits
•     ws.Range("H5").Value = "Elective Credits: " & electCredits
•     ws.Range("H6").Value = "Total Credits: " & totalCredits
•     ws.Range("H7").Value = IIf(totalCredits >= 130, "☐ Meets Credit
Requirement", "☐ Credit Total Below Required Threshold")
•
•     MsgBox "Audit complete. Summary written to column H.",
vbInformation
• End Sub

```

☐ Sheet Setup Required

- Your Excel sheet "PolicingUnits" should include:

A	B	C	D	E	F
Catego ry	Unit ID	Unit Standard Title	NQF Level	Credi ts	Audit Flag

☐ Logigram: Policing Qualification Li

- [Start]
- ↓
- [Enroll in Policing Qualification]
- ↓
- [Complete Core Modules → Law, Ethics, Tactical Skills]
- ↓

- [Complete Fundamental Modules → Justice System, Procedure]
- ↓
- [Select & Complete Elective Modules → Traffic, Domestic Violence, Human Trafficking]
- ↓
- [Undertake Workplace Experience → 5 Credits]
- ↓
- [Integrated Assessment → Written + Practical]
- ↓
- [Moderation & Certification]
- ↓
- [Articulate to Advanced Diplomas or Sector-Specific Roles]
- ↓
- [End]
- I can extend this into a printable moderation sheet or automate international benchmarking alignment. Want me to scaffold that next?

□ Scope Overview: Occupational Certificate - Weapon Systems Mechanic (Combat Weapons Fitter)

□ Purpose

To prepare learners to maintain, repair, and test combat weapon systems, ensuring operational readiness of the South African National Defence Force.

□ Structure

- **Total Credits:** 543
- **NQF Level:** 4
- **Qualification Type:** Occupational Certificate
- **Sub-framework:** OQSF (QCTO)
- **Modules:**
 - **Knowledge:** 148 credits (mechanical, electrical, environmental, surface treatment)
 - **Practical Skills:** 222 credits (inspection, maintenance, administration)
 - **Work Experience:** 173 credits (operational inspection, serviceability tasks)

□ Articulation

- **Horizontal:** Boilermaker (ID 93626), Fitter & Turner (ID 94020)
- **Vertical:** Millwright (Level 5), National N Diploma in Engineering Studies (Level 6)

▣ VBA Module: Combat Weapon Maintenance Tracker

This module:

- Validates credit totals across modules
- Logs inspection and serviceability status
- Flags missing or duplicate entries
- Supports audit, moderation, and trade test readiness

vb

```
Sub AuditCombatWeaponsFitter()  
    Dim ws As Worksheet  
    Dim lastRow As Long, i As Long  
    Dim kmCredits As Double, pmCredits As Double, wmCredits As Double  
    Dim totalCredits As Double  
    Dim moduleCode As String  
    Dim dictModules As Object  
    Set dictModules = CreateObject("Scripting.Dictionary")  
  
    ' Set worksheet  
    Set ws = ThisWorkbook.Sheets("CombatWeaponsModules")  
  
    ' Find last row  
    lastRow = ws.Cells(ws.Rows.Count, "A").End(xlUp).Row  
  
    ' Loop through modules  
    For i = 2 To lastRow  
        moduleCode = ws.Cells(i, 2).Value  
  
        ' Check for duplicates  
        If dictModules.exists(moduleCode) Then  
            ws.Cells(i, 6).Value = "⚠ Duplicate"  
        Else  
            dictModules.Add moduleCode, True  
        End If  
  
        ' Credit calculation by type  
        Select Case ws.Cells(i, 1).Value  
            Case "KM": kmCredits = kmCredits + ws.Cells(i, 4).Value  
            Case "PM": pmCredits = pmCredits + ws.Cells(i, 4).Value  
            Case "WM": wmCredits = wmCredits + ws.Cells(i, 4).Value  
        End Select  
    Next i  
  
    totalCredits = kmCredits + pmCredits + wmCredits  
  
    ' Output summary  
    ws.Range("H2").Value = "Combat Weapons Fitter Qualification Summary"  
    ws.Range("H3").Value = "Knowledge Module Credits: " & kmCredits  
    ws.Range("H4").Value = "Practical Module Credits: " & pmCredits  
    ws.Range("H5").Value = "Work Experience Credits: " & wmCredits
```

```

ws.Range("H6").Value = "Total Credits: " & totalCredits
ws.Range("H7").Value = IIf(totalCredits = 543, "☐ Meets Credit Requirement", "☐ Credit Total Invalid")

MsgBox "Audit complete. Summary written to column H.", vbInformation
End Sub

```

☐ Sheet Setup Required

Your Excel sheet "CombatWeaponsModules" should include:

A	B	C	D	E	F
Typ	Module	Module	Credi	Delivery	Audit
e	Code	Title	ts	Status	Flag

☐ Logigram: Combat Weapons Fitter Lifecycle

☐ Objective: Maintain Combat Weapon Systems for Operational Readiness

```

[Start]
↓
[Receive Weapon System]
↓
[Perform Pre-Fire Inspection]
↓
[Record Serviceability → Job Card]
↓
[Diagnose Faults → Mechanical / Electrical / Surface]
↓
[Strip & Repair → Replace Modules]
↓
[Apply Surface Treatment → Cure]
↓
[Reassemble & Test Functionality]
↓
[Test Fire → Confirm Rate of Fire]
↓
[Post-Fire Inspection → Final Job Card]
↓
[Update Maintenance Records → Archive]
↓
[End]

```

I can extend this into a printable moderation sheet or automate trade test readiness tracking. Want me to scaffold that next?

□ **Scope Overview: Technological Capability Establishment in Defence**

□ **Purpose**

To equip learners in defence and security acquisition roles with the ability to:

- Initiate and apply technological capability development
- Integrate risk-reduction strategies into acquisition programmes
- Align operational needs with technology push-pull dynamics
- Manage tailored contracts for capability development

□ **Core Competencies**

- Capability gap analysis (operational vs. technological)
- Risk-reduction planning (proof-of-principle, demonstrators)
- Contract tailoring (configuration, financial, approval procedures)
- Progress estimation and stakeholder reporting
- Flexibility in managing SET contracts

□ **Embedded Knowledge**

- Defence R&D structures
- Intellectual property principles
- Military strategy and force design
- Technology life cycles and standards

□ **VBA Module: Capability Audit Tracker**

This module:

- Logs programme components

- Validates alignment with capability principles
- Flags missing or non-compliant entries
- Supports audit and moderation traceability
- Sub AuditCapabilityDevelopment()
 - Dim ws As Worksheet
 - Dim lastRow As Long, i As Long
 - Dim programmeID As String, componentType As String
 - Dim alignedFlag As Boolean, riskReductionFlag As Boolean
 - Dim contractTailoredFlag As Boolean, compliantCount As Long
 -
 - ' Set worksheet
 - Set ws = ThisWorkbook.Sheets("CapabilityAudit")
 -
 - ' Find last row
 - lastRow = ws.Cells(ws.Rows.Count, "A").End(xlUp).Row
 - compliantCount = 0
 -
 - ' Loop through records
 - For i = 2 To lastRow
 - programmeID = ws.Cells(i, 1).Value
 - componentType = ws.Cells(i, 2).Value
 - alignedFlag = ws.Cells(i, 3).Value
 - riskReductionFlag = ws.Cells(i, 4).Value
 - contractTailoredFlag = ws.Cells(i, 5).Value
 -
 - If alignedFlag And riskReductionFlag And contractTailoredFlag
 - Then
 - ws.Cells(i, 6).Value = "☐ Compliant"
 - compliantCount = compliantCount + 1
 - Else
 - ws.Cells(i, 6).Value = "☐ Non-Compliant"
 - End If
 - Next i
 -
 - ' Output summary
 - ws.Range("H2").Value = "Capability Development Audit Summary"
 - ws.Range("H3").Value = "Total Programmes: " & lastRow - 1
 - ws.Range("H4").Value = "Compliant: " & compliantCount
 - ws.Range("H5").Value = "Non-Compliant: " & (lastRow - 1 - compliantCount)
 -
 - MsgBox "Audit complete. Summary written to column H.",
 - vbInformation
 - End Sub

- **☐ Sheet Setup Required**

- Your Excel sheet "CapabilityAudit" should include:

A	B	C	D	E	F
Programme ID	Component Type	Aligne d	Risk Reduction	Contract Tailored	Compliance Flag

• □ Logigram / Algorigram Scaffold

• □ Objective: Manage Technological Capability Development in Defence Acquisition

- [Start]
- ↓
- [Identify Operational Need]
- ↓
- [Translate Need → Capability Requirements]
- ↓
- [Review Existing Technological Capability]
- ↓
- [Gap Analysis: Operational vs. Technological]
- ↓
- [Formulate Risk Reduction Activities]
- ↓
- [Select Contract Type]
- ↓
- [Tailor Acquisition Process]
- ↓
- [Implement Capability Development Contract]
- ↓
- [Monitor Progress → Estimate & Report]
- ↓
- [Evaluate Flexibility & Adjustments]
- ↓
- [End]
- I can extend this into a printable moderation template or automate it for credential-linked export. Just say the word and I'll scaffold the next layer.

□ Scope Overview: Bachelor of Engineering in Electrical and Electronic Engineering

□ Purpose

To equip learners with foundational and advanced competencies in mathematics, physics, engineering sciences, design, and emerging technologies, preparing them for professional engineering practice and further academic progression.

□ Structure

- **Total Credits:** 604
- **NQF Level:** 8
- **Qualification Type:** National First Degree
- **Sub-framework:** HEQSF (CHE)
- **Modules:**
 - **Level 5:** 156 credits (math, physics, design, accounting, Java)
 - **Level 6:** 152 credits (calculus, electronics, sustainability, C++)
 - **Level 7:** 152 credits (systems, signal processing, instrumentation, software)
 - **Level 8:** 120 credits + 24 elective credits (control, power, research, entrepreneurship)

□ Articulation

- **Horizontal:** BSc Computer Science, LLB, PG Diplomas
- **Vertical:** MBA, MPhil in Water Management or Information Science

□ VBA Module: Engineering Qualification Credit Tracker

This module:

- Validates credit totals across all levels
- Flags missing or duplicate modules
- Supports audit traceability and curriculum compliance

vb

```
Sub AuditEngineeringQualification()
    Dim ws As Worksheet
    Dim lastRow As Long, i As Long
    Dim level5Credits As Double, level6Credits As Double
    Dim level7Credits As Double, level8Credits As Double
    Dim electiveCredits As Double, totalCredits As Double
    Dim moduleTitle As String
    Dim dictModules As Object
    Set dictModules = CreateObject("Scripting.Dictionary")

    ' Set worksheet
    Set ws = ThisWorkbook.Sheets("EngineeringModules")

    ' Find last row
    lastRow = ws.Cells(ws.Rows.Count, "A").End(xlUp).Row

    ' Loop through modules
    For i = 2 To lastRow
        moduleTitle = ws.Cells(i, 2).Value

        ' Check for duplicates
```



```

If dictModules.exists(moduleTitle) Then
    ws.Cells(i, 5).Value = "⚠ Duplicate"
Else
    dictModules.Add moduleTitle, True
End If

' Credit calculation by level
Select Case ws.Cells(i, 1).Value
    Case 5: level5Credits = level5Credits + ws.Cells(i, 3).Value
    Case 6: level6Credits = level6Credits + ws.Cells(i, 3).Value
    Case 7: level7Credits = level7Credits + ws.Cells(i, 3).Value
    Case 8
        If ws.Cells(i, 4).Value = "Elective" Then
            electiveCredits = electiveCredits + ws.Cells(i, 3).Value
        Else
            level8Credits = level8Credits + ws.Cells(i, 3).Value
        End If
    End Select
Next i

totalCredits = level5Credits + level6Credits + level7Credits +
level8Credits + electiveCredits

' Output summary
ws.Range("G2").Value = "Engineering Qualification Credit Summary"
ws.Range("G3").Value = "Level 5 Credits: " & level5Credits
ws.Range("G4").Value = "Level 6 Credits: " & level6Credits
ws.Range("G5").Value = "Level 7 Credits: " & level7Credits
ws.Range("G6").Value = "Level 8 Credits: " & level8Credits
ws.Range("G7").Value = "Elective Credits: " & electiveCredits
ws.Range("G8").Value = "Total Credits: " & totalCredits
ws.Range("G9").Value = IIf(totalCredits = 604, "☑ Meets Credit
Requirement", "☐ Credit Total Invalid")

MsgBox "Audit complete. Summary written to column G.", vbInformation
End Sub

```

☐ Sheet Setup Required

Your Excel sheet "EngineeringModules" should include:

A	B	C	D	E
NQF Level	Module Title	Credi ts	Type (Core/Elective)	Audit Flag

Would you like me to scaffold a logigram that maps th

Thanks Tshingombe — to support your SAQA Conference 2025 registration and audit traceability, here's a tailored **Visual Basic for Applications**

(VBA) module and a **logigram scaffold** that automates and visualizes your registration workflow.

□ VBA Module: SAQA Conference Registration Tracker

This module:

- Logs delegate registration details
- Validates payment status and category
- Flags missing or duplicate entries
- Supports audit, billing, and reporting

vb

```
Sub AuditConferenceRegistration()  
    Dim ws As Worksheet  
    Dim lastRow As Long, i As Long  
    Dim delegateName As String, category As String  
    Dim paymentStatus As String, visaRequired As String  
    Dim compliantCount As Long  
  
    ' Set worksheet  
    Set ws = ThisWorkbook.Sheets("SAQARegistration")  
  
    ' Find last row  
    lastRow = ws.Cells(ws.Rows.Count, "A").End(xlUp).Row  
    compliantCount = 0  
  
    ' Loop through registrations  
    For i = 2 To lastRow  
        delegateName = ws.Cells(i, 1).Value  
        category = ws.Cells(i, 2).Value  
        paymentStatus = ws.Cells(i, 3).Value  
        visaRequired = ws.Cells(i, 4).Value  
  
        If paymentStatus = "Paid" And category <> "" Then  
            ws.Cells(i, 5).Value = "□ Registered"  
            compliantCount = compliantCount + 1  
        Else  
            ws.Cells(i, 5).Value = "□ Incomplete"  
        End If  
    Next i  
  
    ' Output summary  
    ws.Range("G2").Value = "SAQA Conference Registration Summary"  
    ws.Range("G3").Value = "Total Delegates: " & lastRow - 1  
    ws.Range("G4").Value = "Confirmed Registrations: " & compliantCount  
    ws.Range("G5").Value = "Pending/Incomplete: " & (lastRow - 1 -  
compliantCount)  
  
    MsgBox "Audit complete. Summary written to column G.", vbInformation
```

End Sub

□ Sheet Setup Required

Your Excel sheet "SAQARegistration" should include:

A	B	C	D	E
Delegate Name	Catego ry	Payme nt	Visa Letter	Registration Status

□ Logigram: SAQA Conference Registration Workflow

□ Objective: Confirm Delegate Registration for SAQA Conference 2025

plaintext

```
[Start]
↓
[Complete Online Registration Form]
↓
[Select Category → Student / Professional / Other]
↓
[Confirm Billing Details → Name, VAT, Address]
↓
[Choose Registration Type → Full / Workshop / Dinner]
↓
[Receive Invoice → R4,500 incl. VAT]
↓
[Make Payment → EFT / Credit Card]
↓
[Send Proof to lea@soafrica.com]
↓
[Receive Confirmation Email]
↓
[Attend Conference & Gala Dinner (8 October 2025)]
↓
[End]
```

I can extend this into a printable attendance sheet or automate badge generation based on registration status. Want me to scaffold that next?

Thanks Tshingombe — based on your request, here's a tailored **Visual Basic for Applications (VBA)** module that automates the generation of a printable **SAQA-aligned Certificate of Evaluation** for a student across NQF Levels 6-9.

This module:

- Logs student details
- Maps subjects and credits by NQF level
- Prepares a certificate layout for printing
- Supports audit traceability and qualification verification

□ VBA Module: SAQA Certificate Generator (NQF 6-9)

vb

```
Sub GenerateSAQACertificate()  
    Dim ws As Worksheet  
    Dim certSheet As Worksheet  
    Dim lastRow As Long, i As Long  
    Dim studentName As String  
    Dim level As Integer, subject As String, credits As Double  
    Dim certRow As Integer  
  
    ' Set worksheets  
    Set ws = ThisWorkbook.Sheets("StudentSubjects")  
    Set certSheet = ThisWorkbook.Sheets("Certificate")  
  
    ' Clear previous certificate  
    certSheet.Cells.ClearContents  
    certRow = 2  
  
    ' Header  
    certSheet.Range("A1").Value = "SAQA Certificate of Evaluation"  
    certSheet.Range("A2").Value = "Student Name: Tshingombe Tshitadi"  
    certSheet.Range("A3").Value = "Issued: " & Format(Date, "dd mmmm yyyy")  
    certSheet.Range("A4").Value = "NQF Levels Covered: 6, 7, 8, 9"  
    certRow = 6  
  
    ' Table headers  
    certSheet.Cells(certRow, 1).Value = "NQF Level"  
    certSheet.Cells(certRow, 2).Value = "Subject"  
    certSheet.Cells(certRow, 3).Value = "Credits"  
    certRow = certRow + 1  
  
    ' Loop through student subjects  
    lastRow = ws.Cells(ws.Rows.Count, "A").End(xlUp).Row  
    For i = 2 To lastRow  
        level = ws.Cells(i, 1).Value  
        subject = ws.Cells(i, 2).Value  
        credits = ws.Cells(i, 3).Value  
  
        If level >= 6 And level <= 9 Then  
            certSheet.Cells(certRow, 1).Value = "NQF Level " & level  
            certSheet.Cells(certRow, 2).Value = subject  
            certSheet.Cells(certRow, 3).Value = credits  
            certRow = certRow + 1  
        End If  
    Next i  
End Sub
```

```

        End If
    Next i

    MsgBox "Certificate generated on 'Certificate' sheet.", vbInformation
End Sub

```

□ Sheet Setup Required

Sheet Name: "StudentSubjects"

A	B	C
NQF	Subje	Credit
Level	ct	s

Sheet Name: "Certificate" → This sheet will be auto-filled with certificate content.

```

[Start]
↓
[Input Student Details → Name, Subjects, Credits]
↓
[Filter Subjects by NQF Level 6–9]
↓
[Map Subjects to Certificate Layout]
↓
[Generate Certificate Sheet]
↓
[Print or Export for SAQA Verification]
↓
[End]

```

I can help you extend this to include serial numbers, security features, or bilingual formatting for institutional submission. Ready to scaffold that next?



aux expériences sont
médias. Ces derniers
ts de mesure des diffé-

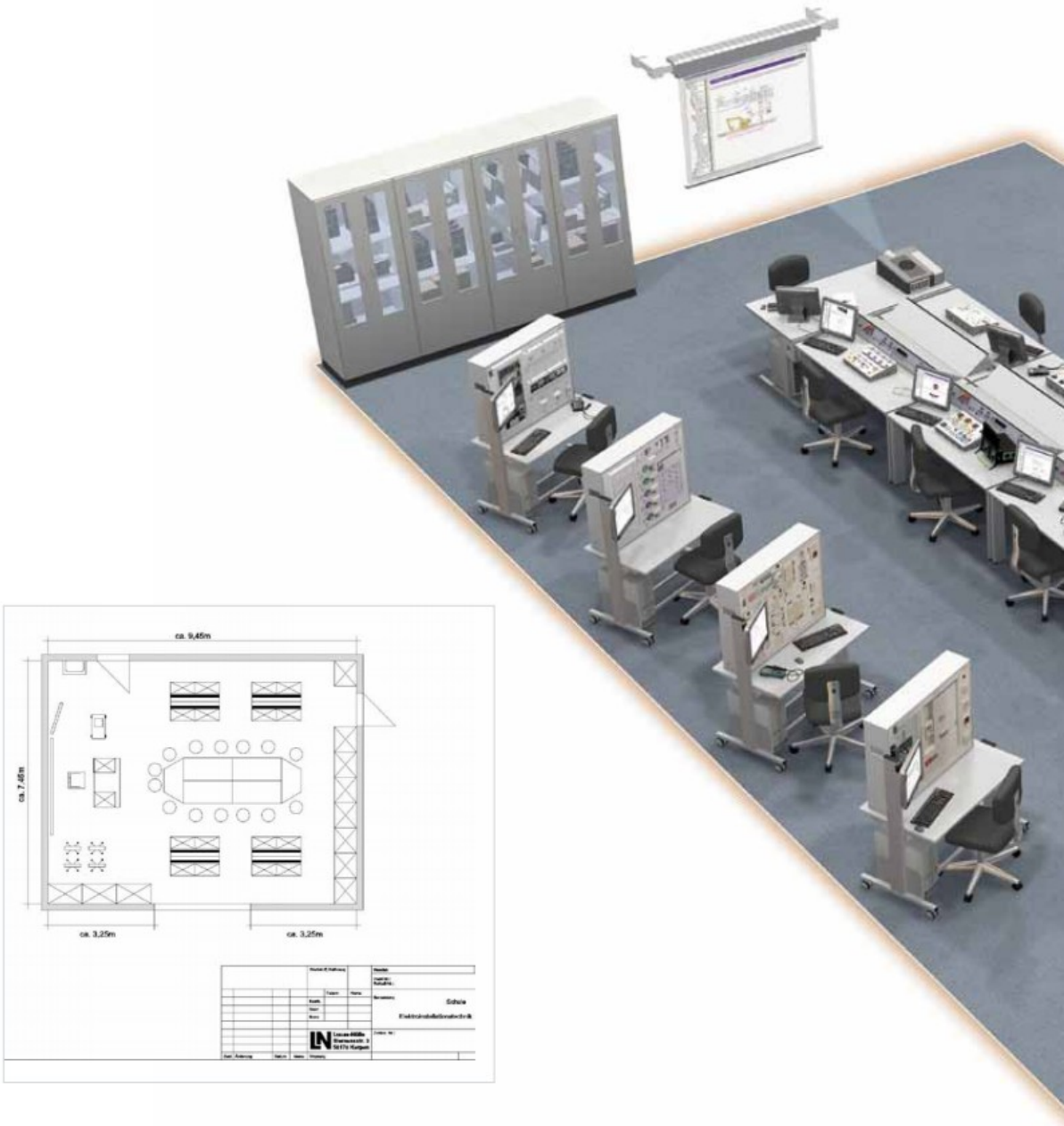
ontenus suivants :

- Test de connaissances
- Montage interactif des expériences
- Barres de navigation
- Théorie animée



Une solution complète

L'aménagement et l'équipement d'un laboratoire technologique haut de gamme exige une planification soignée et qualifiée. Il est indispensable de prendre en compte tant les objectifs de la formation et de l'apprentissage que les conditions constructives et locales. Disposant du savoir-faire requis et jouissant d'une longue expérience en la matière, nous vous apportons volontiers nos conseils.







Référence article : SO4204-4D, constitué de

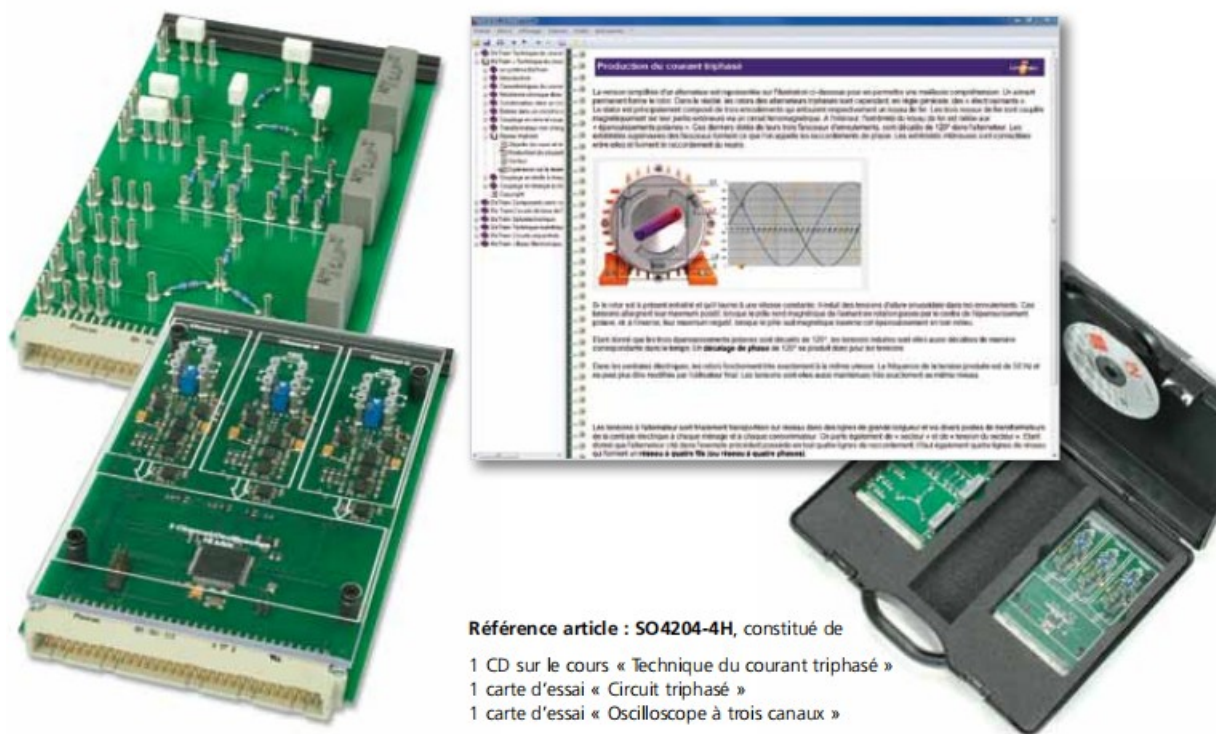
- 1 CD-ROM sur le cours « Technique du courant continu »
- 1 carte d'essai « Circuits à résistances »
- 1 carte d'essai « Diviseur de tension »
- 1 carte d'essai « Résistances variables »

Contenus didactiques

- Termes de base : charge électrique, champ électrique, courant, tension, résistance et puissance
- Manipulation d'appareils de mesure et de sources de tension
- Démonstration par l'expérience des lois d'Ohm et de Kirchhoff
- Mesures sur des circuits en série, des circuits parallèles et des diviseurs de tension
- Enregistrement des caractéristiques de résistances variables (Photo-résistance, CTR, CTR, VDR)
- Bobine et condensateur dans un circuit de courant continu
- Recherche d'erreurs

Montage en étoile et en triangle – Alternateur triphasé

Le courant triphasé revêt une importance particulière dans le domaine de la technique énergétique et de la technique de transmission, aussi bien dans la production et le transport d'énergie électrique que dans le fonctionnement de machines industrielles à haute performance.



Référence article : SO4204-4H, constitué de

- 1 CD sur le cours « Technique du courant triphasé »
- 1 carte d'essai « Circuit triphasé »
- 1 carte d'essai « Oscilloscope à trois canaux »

Contenus didactiques

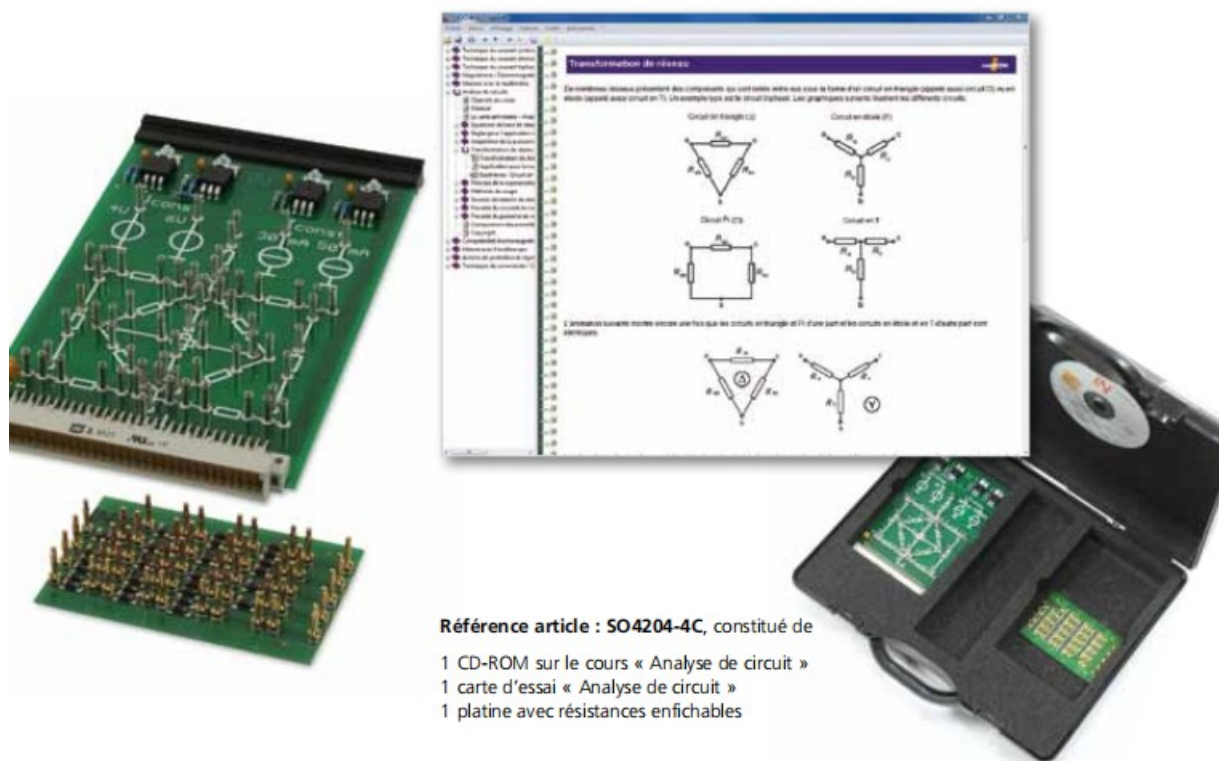
- Mesure de grandeurs de ligne et de branche
- Détermination des rapports entre tensions de phase et de ligne
- Consommateurs ohmiques et capacitifs dans un circuit en étoile et en triangle
- Déphasage entre tensions de phase et de ligne
- Mesure des courants de compensation dans le neutre
- Conséquences d'interruptions du neutre
- Mesures de courant et de tension en cas de charges équilibrées et déséquilibrées
- Mesure de puissance sur une charge triphasée



Référence article : SO4204-4K, constitué de
 1 CD-ROM sur le cours
 « Compatibilité électromagnétique »
 1 carte d'essai « Compatibilité électromagnétique »

Contenus didactiques

- Le terme de compatibilité électromagnétique (CEM)
- Description des effets de couplage électromagnétiques
- Sources perturbatrices électromagnétiques naturelles et artificielles
- Normes et directives CEM européennes
- Etude du couplage galvanique entre des pistes conductrices parallèles
- Etude du couplage capacitif entre des pistes conductrices
- Etude du couplage inductif entre des pistes conductrices parallèles
- Mesures pour améliorer les propriétés CEM d'un circuit
- Mesures pour accroître la résistance au brouillage d'un circuit



Référence article : SO4204-4C, constitué de
 1 CD-ROM sur le cours « Analyse de circuit »
 1 carte d'essai « Analyse de circuit »
 1 platine avec résistances enfichables

Contenus didactiques

- Equations de Kirchhoff pour un réseau de résistances
- Analyse de réseaux de résistances à l'aide des équations de Kirchhoff
- Adaptation de la puissance dans les circuits de résistances
- Transformation étoile-triangle
- Apprentissage et application du principe de superposition
- Source de courant et de tension de remplacement
- Simplification d'un réseau de résistance avec 2 sources à l'aide du théorème de Millman
- Transformation de la source de tension de remplacement en source de courant de remplacement
- Procédé du courant de maille et procédé de potentiel de nœud



Contenus didactiques

- Montage de différents régimes de neutre (TN, TT, IT)
- Protection contre un contact direct et indirect
- Protection par coupure de protection
- Protection par petite tension de protection
- Dispositifs de protection contre les surintensités
- Dispositifs différentiels résiduels
- Mesures et contrôles de mesures de protection
- Mesure de la résistance des conducteurs de protection
- Mesure de la résistance d'isolement
- Test DDR avec et sans déclenchement
- Mesure de terre
- Mesure de la résistance de boucle





Domaines didactiques 4 et 7

- Mise à disposition de systèmes informatiques
- Communication à la maison et au bureau

Système d'entraînement de bâtiment
« Technique de communication »,

page 36



Domaines didactiques 1 et 2

- Réalisation de circuits d'installation électrique avec distributions principale et secondaire
- Vérification des mesures de protection

Système d'entraînement de bâtiment
« Circuits de lampes et d'appareils »

page 34

Domaine didactique 9

- Dispositifs de détection de danger et d'incendie
- Installations de communication
- Gestion technique du bâtiment et ses composants
- Gestion des charges

Système d'entraînement de bâtiment
« Gestion technique du bâtiment avec KNX®/EIB »

page 38
page 40

« Détection de dangers »



Domaines didactiques 1 et 5

- Alimentation domestique
- Mesures de protection selon DIN VDE 0100, 600e partie
- Contrôle répété selon DIN VDE 0701/0702

Système d'entraînement de bâtiment
« Alimentation domestique »

page 32



Le défi

Le monde de la formation et de l'enseignement continu est en mutation perpétuelle :

- Les contenus didactiques sont de plus en plus complexes et orientés projet
- Les cycles de vie réduits des produits et les innovations permanentes exigent un apprentissage continu
- Les budgets alloués à la formation diminuent
- De nouvelles formes d'apprentissage sont requises

La solution pour une transmission moderne des contenus de formation

- InsTrain : une combinaison de nouveaux médias didactiques avec des systèmes d'expérimentation
- Le système d'expérimentation permet d'apprendre sur le PC et de s'entraîner sur des appareils industriels
- Plusieurs modèles thématiques qui permettent un travail interactif avec le logiciel du PC via une interface intégrée et un simulateur d'erreurs universel
- Pour augmenter la part d'autoapprentissage, l'utilisateur est guidé pas à pas par un didacticiel multimédia
- Les unités didactiques animées multimédias présentent toute la théorie et guident l'utilisateur dans la réalisation des expériences pratiques

Compétence pratique

Par la réorganisation des métiers de l'électricité et l'orientation vers des domaines didactiques, la formation attache une grande importance à la pratique. La combinaison des nouveaux médias avec les systèmes d'expérimentation joue un rôle prépondérant, car l'autoapprentissage sur des projets issus de la pratique offre les meilleures conditions possibles pour une transmission durable des compétences.

Conforme aux normes VDE / EN

Les contenus didactiques du système d'entraînement de bâtiment « InsTrain » se réfèrent à la norme VDE / EN en vigueur dans toute l'Europe.

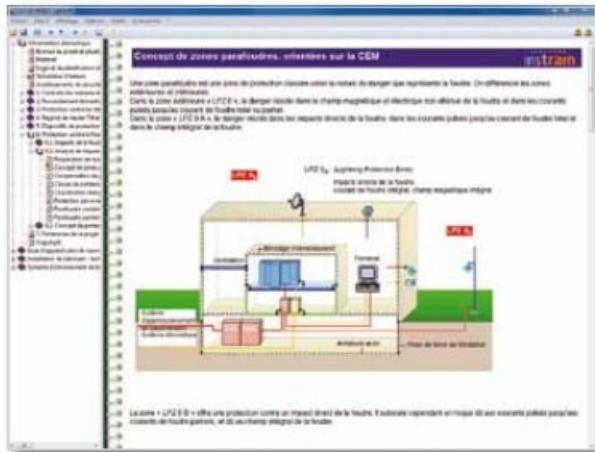
Des versions nationales spécifiques sont disponibles sur demande.



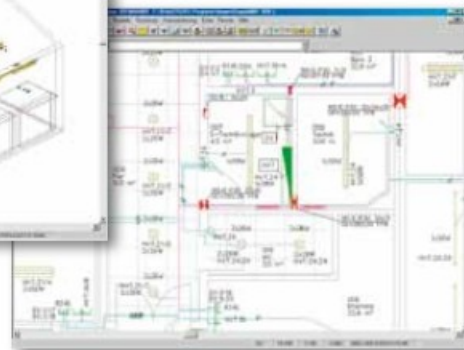
LabSoft

LabSoft est l'interface de contrôle d'InsTrain, une plate-forme d'expérimentation ouverte qui permet d'accéder à tous les médias du laboratoire :

- Fenêtre de navigation avec structure en arborescence pour un affichage et une sélection directs de tous les composants des cours
- Réalisation des expériences, documentation incluse
- Évaluation et enregistrement des résultats de mesure
- Simulateur d'erreurs intégré
 - Voltmètre, ampèremètre
 - Oscilloscope à mémoire à 3 canaux



Plan de fondation 2D/3D



Plan d'installation 2D/3D

Logiciel de planification

Ce logiciel permet la planification complète d'un bâtiment. Il couvre les domaines de l'installation électrique, du sanitaire, du chauffage, de la climatisation et de la ventilation. Au cours de la CAO avec des systèmes modernes, les composants sont adaptés dans un espace virtuel. Les apprenants travaillent avec des logiciels ultra-modernes, conformes à la pratique.

LabSoft en réseau

LabSoft convient aussi bien pour une installation locale, sur l'ordinateur de l'utilisateur, que sur un serveur central accessible depuis l'Intranet ou Internet. Pour faciliter son intégration dans les systèmes de gestion d'apprentissage, LabSoft est développé par Lucas-Nülle dans le respect des standards internationaux.



Labsoft Classroom Manager

Le LabSoft Classroom Manager est un logiciel de gestion complet pour le système InsTrain et tous les cours LabSoft. Le Classroom Manager est constitué des éléments de programme suivants :

LabSoft Reporter :

Contrôle des acquis et statistiques

LabSoft Editor :

Création et édition de cours et de tests

LabSoft Manager :

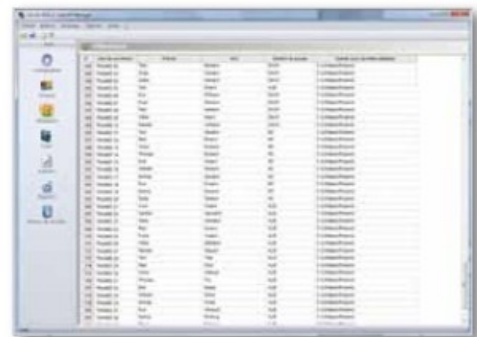
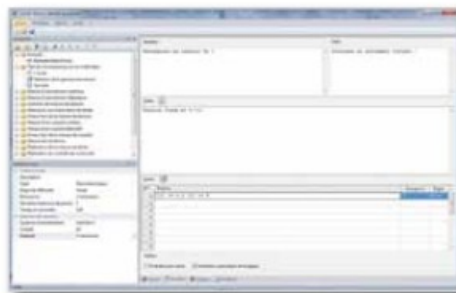
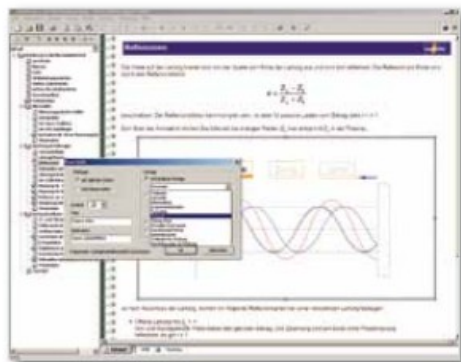
Gestion des données utilisateurs et des cours sous LabSoft

LabSoft Test Creator :

Création d'examens

LabSoft Questioner :

Réalisation de questions (d'examen) et d'exercices de mesure

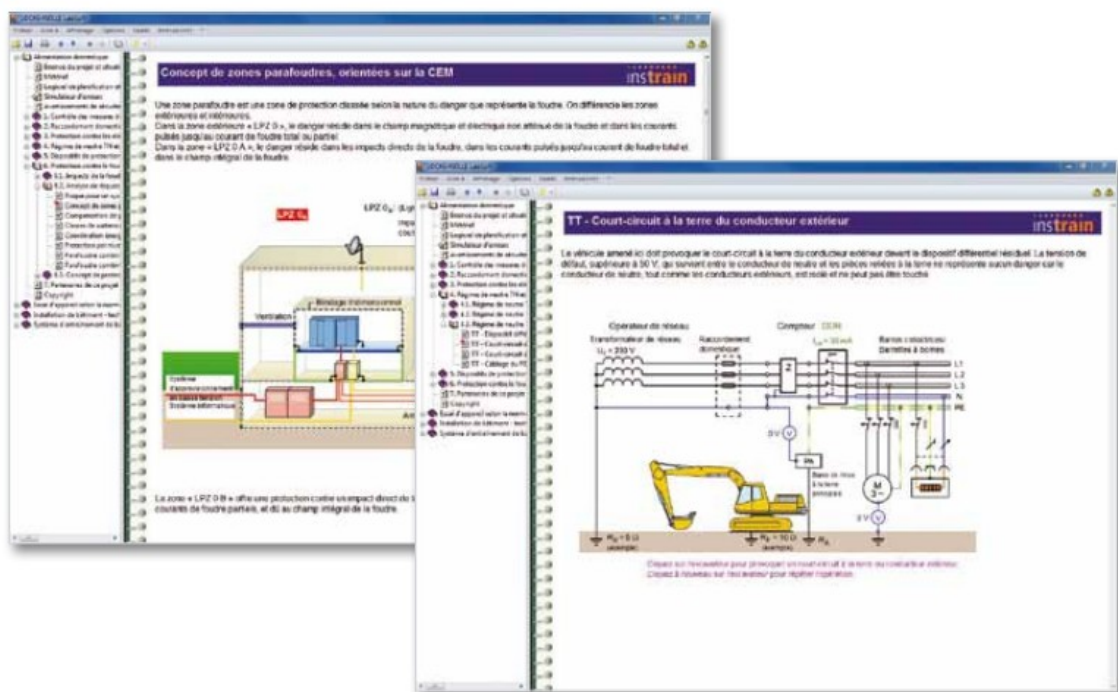


riences orientées vers la pratique sont déjà intégrées. Le simulateur d'erreurs intégré propose différents exercices de mesure que devront résoudre les apprenants. Le réseau de distribution, l'alimentation domestique et l'installation consommateurs sont représentés en détail compte tenu des mesures de protection requises.



Contenus didactiques

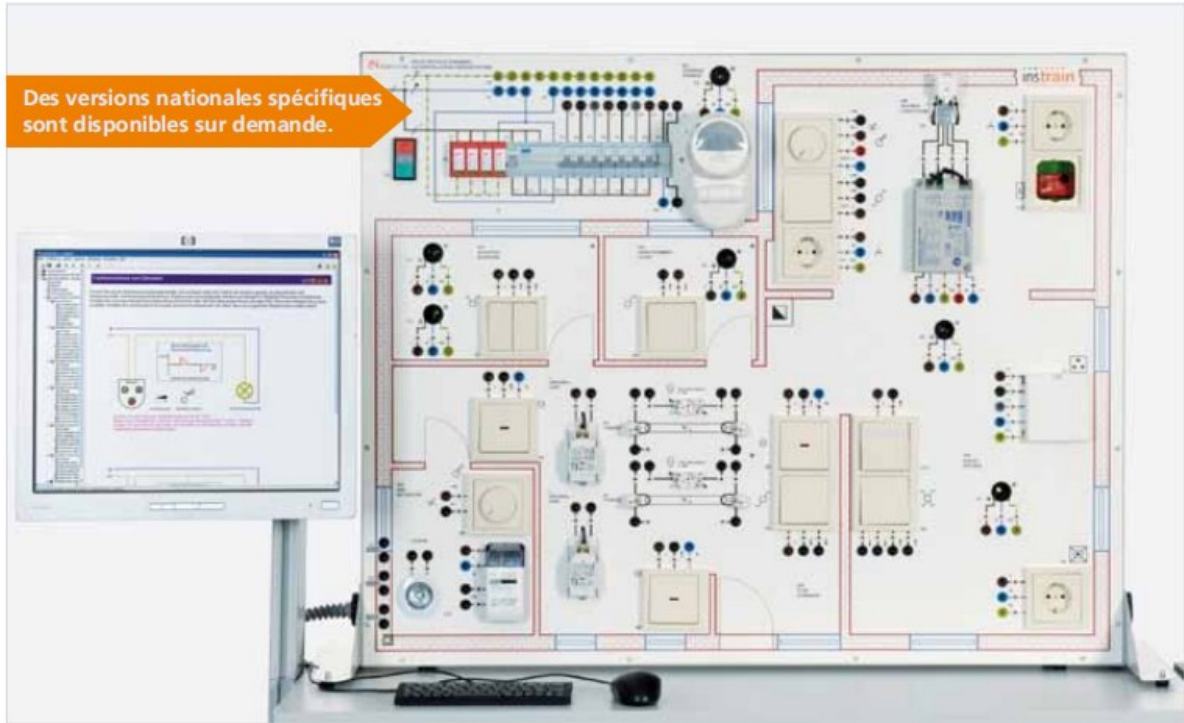
- Structure du réseau public
- Alimentation en énergie électrique, distribution de l'énergie électrique
- Mesures de protection contre les chocs électriques
- Court-circuit, court-circuit à la masse, court-circuit à la terre
- Protection contre la foudre et les surtensions
- Contrôle de champ tournant, mesure du conducteur neutre, mesure de compensation de potentiel
- Fonctionnement de compteurs d'énergie conventionnels et électroniques
- Contrôle des mesures de protection d'après le protocole pour premier contrôle et contrôles répétés
- Distribution secondaire, planification, structure



Matériel fourni

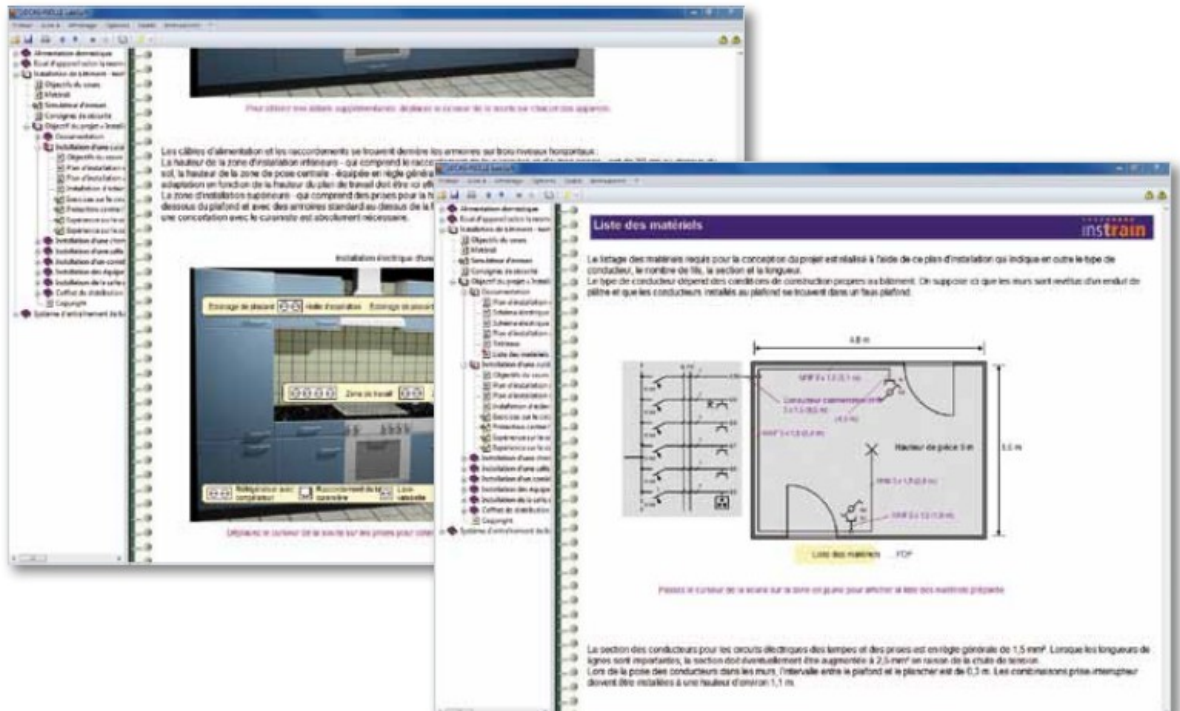
- CD-rom avec navigateur LabSoft et logiciel du cours

Des versions nationales spécifiques sont disponibles sur demande.



Contenus didactiques

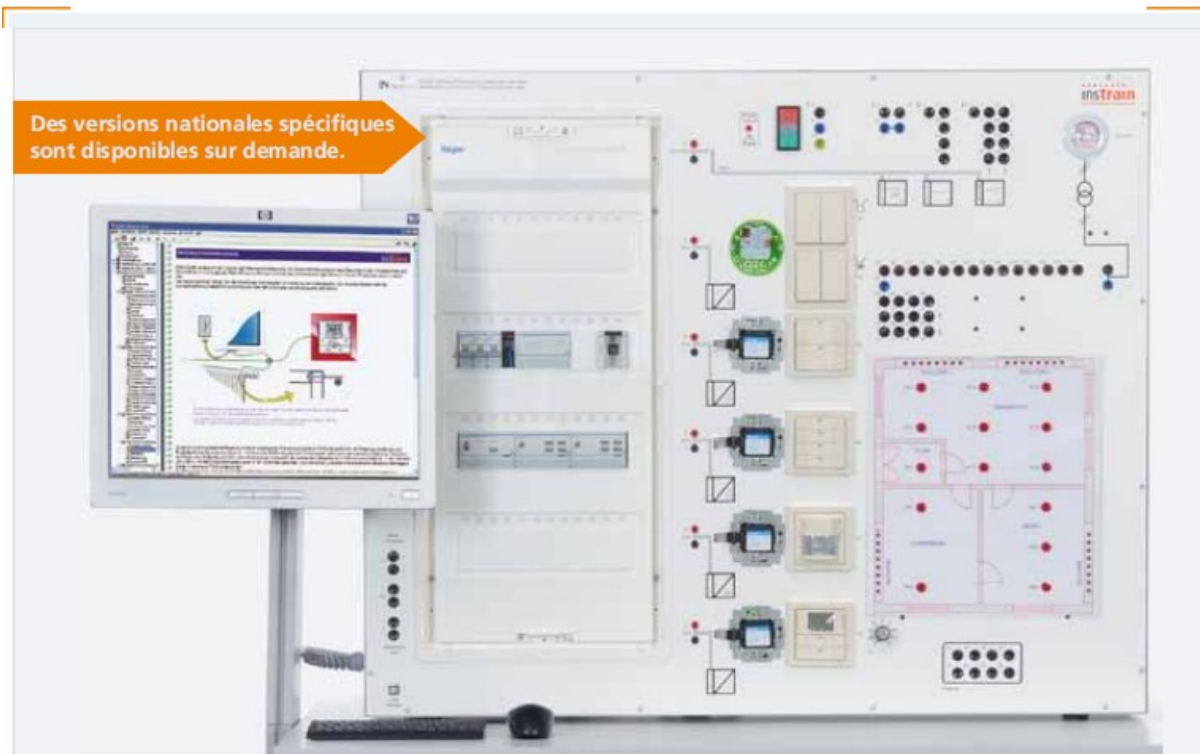
- Planification de l'installation complète d'un appartement
- Recherche et sélection d'équipements avec le client
- Réception et formation du client à la technique installée
- Installation de différentes applications

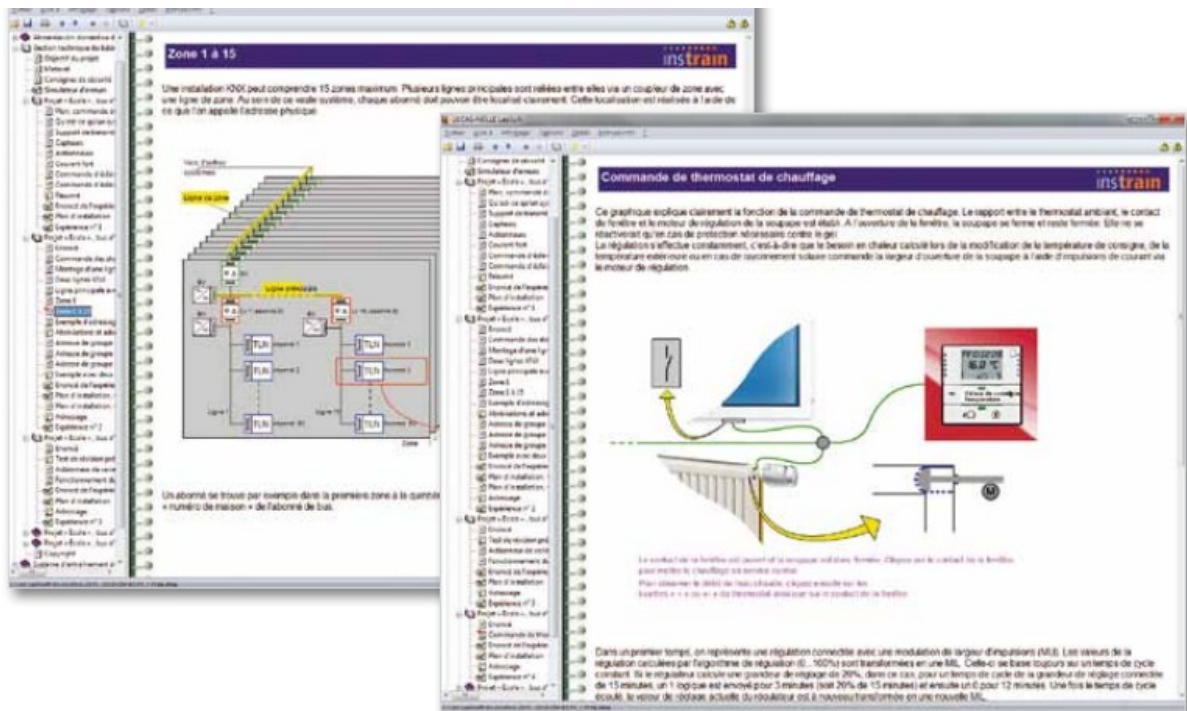


Des versions nationales spécifiques
sont disponibles sur demande.



Des versions nationales spécifiques
sont disponibles sur demande.





multi-usages et d'une grande flexibilité grâce à la structure modulaire

Flexibles

Que ce soit pour l'enseignement magistral ou des expériences réalisées par les élèves dans des conditions pratiques, le système à plaques d'expérimentation permet d'appliquer les méthodes d'enseignement et d'apprentissage les plus variées. La hauteur des plaques correspond au format A4. Les plaques se laissent ainsi accrocher aisément dans les bancs d'expérimentation. La référence directe à la pratique est l'un des points essentiels des systèmes didactiques LN. Tous les systèmes didactiques LN proposent des composants utilisés habituellement dans l'industrie. Au cours des essais, les mesures sont effectuées avec des instruments de mesure industriels.



Modulaires

Conjointement au boîtier en forme de pupitre, la taille A4 offre un outil didactique universel pouvant être utilisé séparément ou combiné à d'autres systèmes.

Le temps de mise en place est réduit au strict minimum. La majeure partie du temps peut donc être consacrée à la formation

Sûrs

Toutes les connexions requises sont dotées de douilles de sécurité.

Pour les tensions appartenant à la catégorie des très basses tensions (selon VDE 0100), les connexions sont réalisées en technique de sécurité 2mm. Pour les tensions supérieures à cette limite, elles sont réalisées en technique de sécurité 4mm.



Clairs

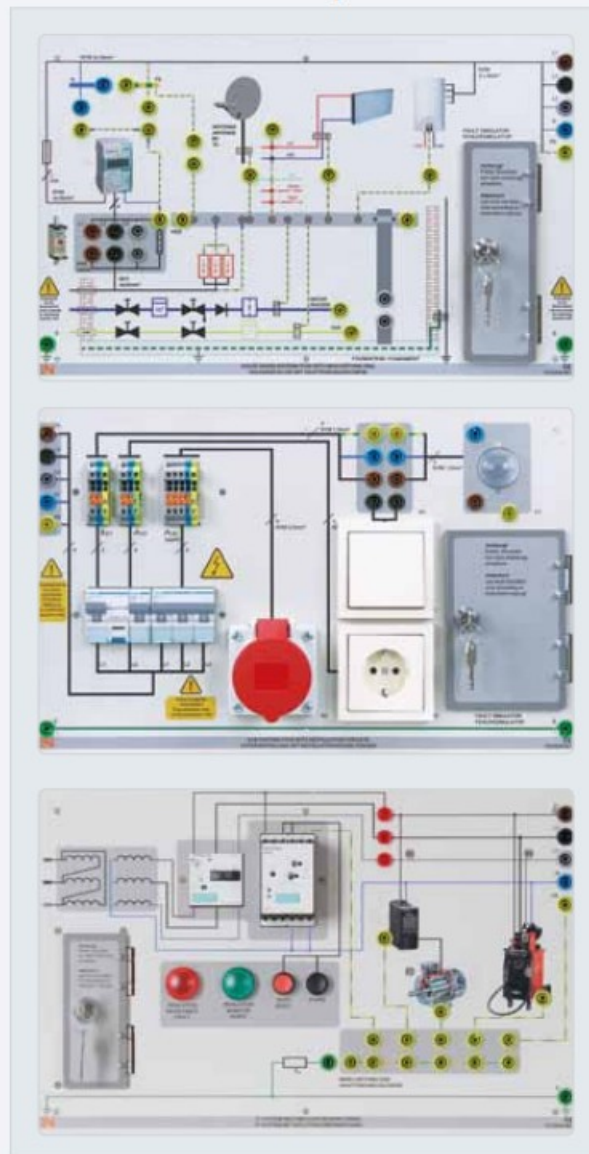
La nouvelle génération de plaques en couleur offre un concept encore plus clair, grâce à l'impression photoréaliste.

Lors du développement des plaques d'expérimentation, LN a attaché une importance particulière à l'impression des symboles et des désignations des fiches de connexion selon les normes.

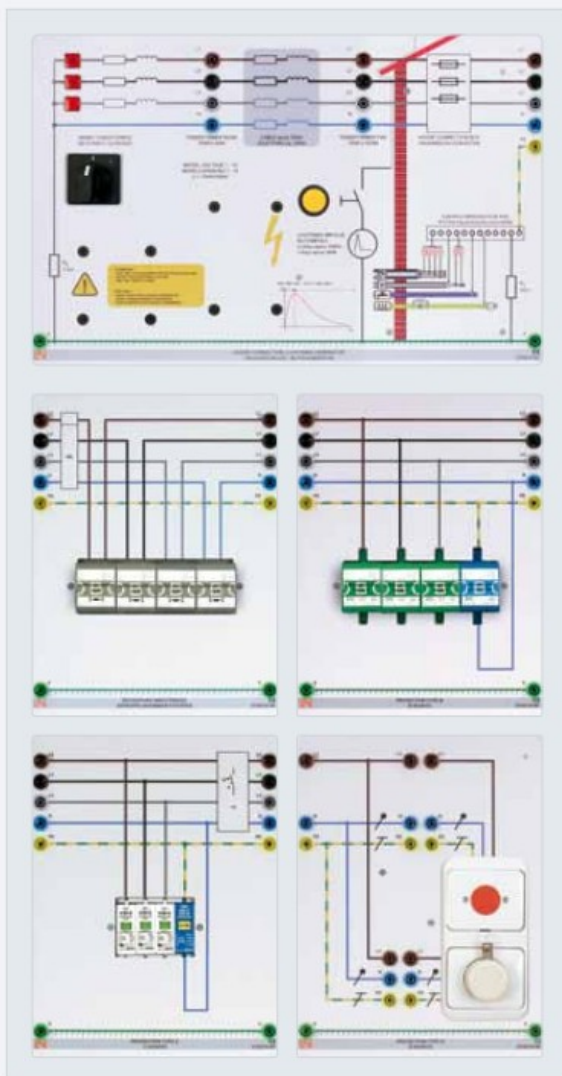
Vos avantages

- Multi-usages et d'une grande flexibilité grâce à la structure modulaire
- Convient parfaitement aux exercices et aux démonstrations
- Sécurité garantie par une double isolation (douilles et câbles de sécurité)
- Grand réalisme par l'intégration d'appareils industriels
- Structure claire grâce à l'impression contrastée et antirayure sur la plaque d'expérimentation
- Technique de mesure moderne avec intégration au PC
- Instructions d'expérimentation et manuels en couleur
- Possibilité de combinaison avec les cours LabSoft
- Fiches de travaux pratiques pour élèves et modèles de solutions

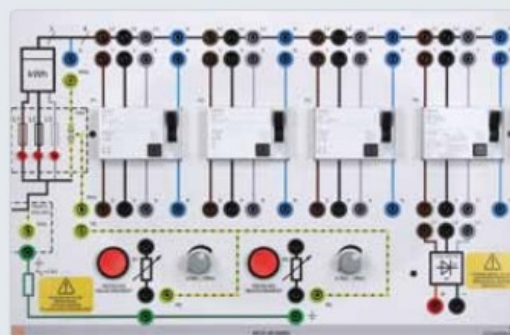
Régimes de neutre et mesures de protection



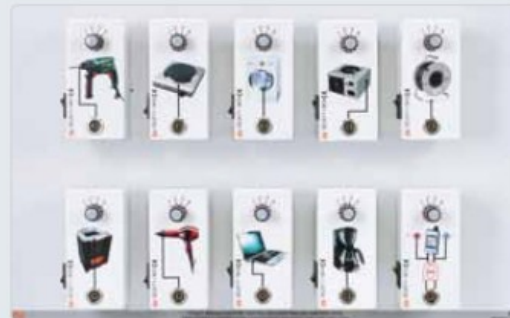
Protection contre la foudre et les surtensions



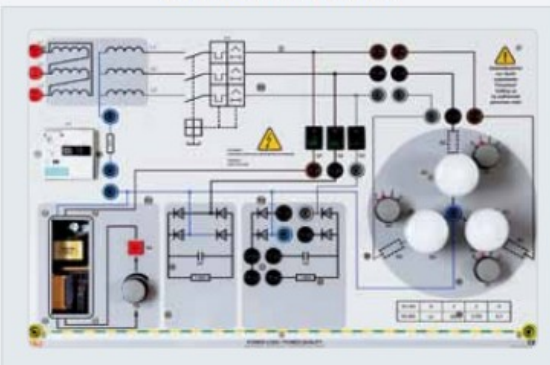
Protection supplémentaire par RCD - DDR (Dispositif Différentiel Résiduel)



Contrôle des équipements électriques



Qualité de réseau



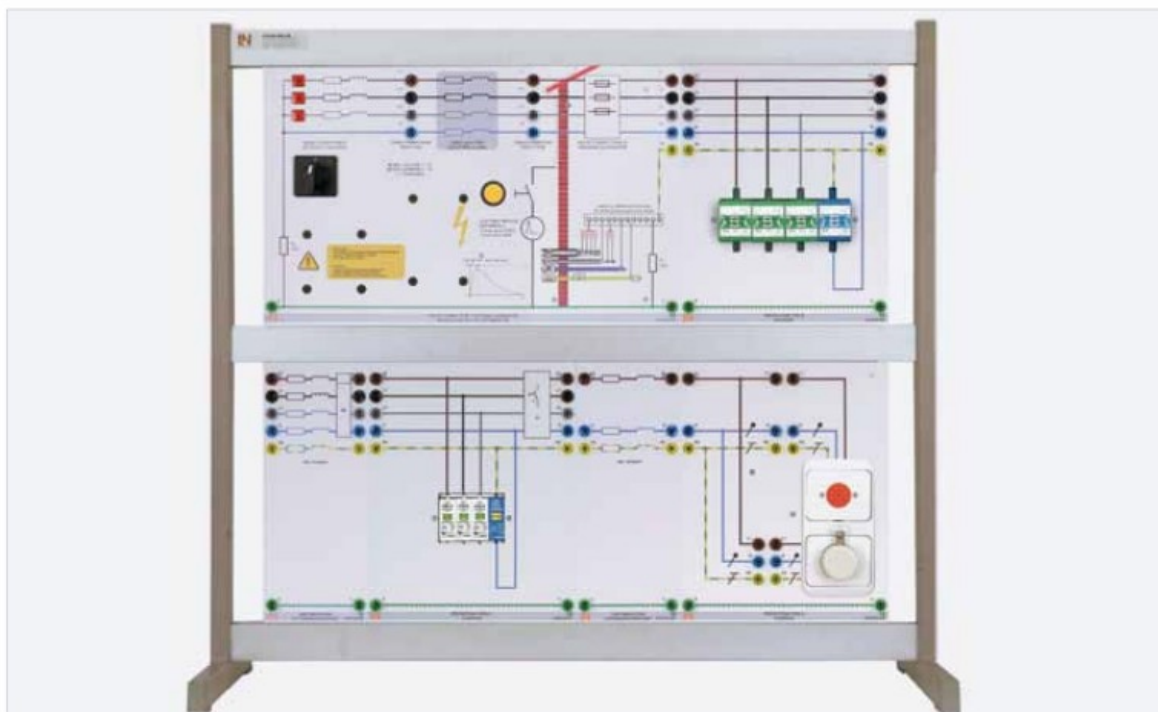
Régimes de neutre et mesures de protection

Le thème de la protection contre les tensions de contact trop élevées (mesures de protection selon VDE 100) est important pour ceux qui, dans leur quotidien professionnel, et notamment les apprentis des métiers de l'électricité, sont chargés de la conception, l'exploitation et de la réparation d'installations électriques. Ce système est une aide idéale pour le cours théorique et pratique de l'apprentissage des mesures de protection des réseaux selon VDE 0100. La référence directe à la pratique est l'un des points essentiels des systèmes didactiques LN. Au cours des essais, les mesures sont effectuées avec des instruments conventionnels.



PROTECTION CONTRE LA Foudre ET LES SURTENSIONS

Le modèle de réseau de protection contre la foudre permet aux futurs ouvriers spécialisés et maîtres, mais aussi aux étudiants, de se familiariser directement aux principes de base de protection contre la foudre utilisant plusieurs niveaux, avec des coupe-circuits de courant et de surtension provoqués par la foudre. Le modèle est constitué d'un système à courant triphasé avec des coupe-circuits de courant et de surtension provoqués par la foudre intégrés et d'un générateur d'impulsions (de courant) destiné au couplage dans le réseau d'un courant de foudre artificiel.



Contenus didactiques

Protection par disjoncteur différentiel selon VDE / EN

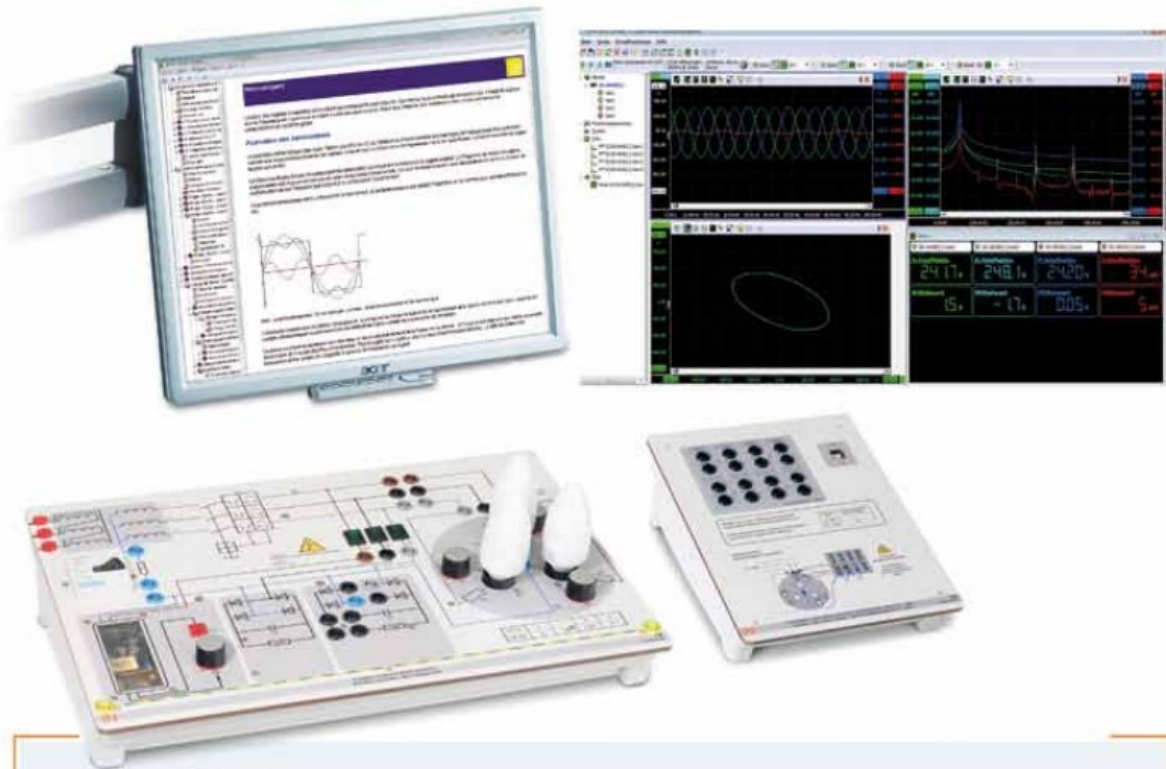
La plaque RCD - DDR présente la structure, le mode de fonctionnement et l'interconnexion judicieuse de différents RCD (Residual Current Protective Devices) - DDR (Dispositif Différentiel Résiduel). La plaque DDR enseigne les contenus suivants : unités DDR dans les régimes de neutre TN ou TT, mesure et appréciation des valeurs de déclenchement (temps, courant de défaut), influence de résistances modifiées (R_{boucle} , R_{terre}) sur les valeurs de déclenchement, élaboration des différences entre les types de DDR A et B, valeurs de déclenchement pour les DDR du type B, étude de la sélectivité de DDR montés en série, mesure des courants de défaut dans le cas d'un courant de défaut alternatif, d'un courant de défaut pulsé et d'un courant de défaut continu.



Contenus didactiques

- Structure et fonctionnement de différents RCD - DDR
- Emploi de DDR dans différents régimes de neutre (TN, TT)
- Sélection des DDR appropriés à l'application (DIN VDE 0100-530:2005-06)
- Structure d'une protection différentielle sélective (DIN VDE 0100-300:1996-01)
- DDR comme protections complémentaires selon DIN CEI 60364-4-41 (VDE 0100-410)
- Emploi de DDR du type B dans des salles de formation (DIN VDE 0100-723)
- Emploi de DDR du type A ou B avec différentes formes de courant de défaut
- Mesure et évaluation de différents critères de déclenchement en cas de courants continus et alternatifs

de réseau en appliquant une technique de mesure directe.

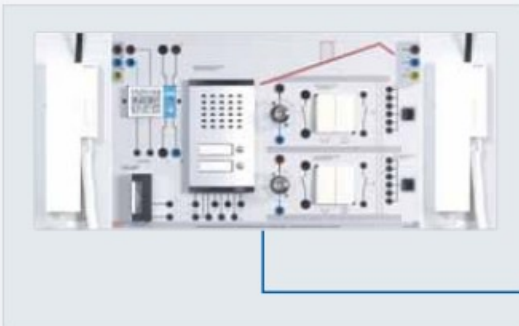


Contenus didactiques

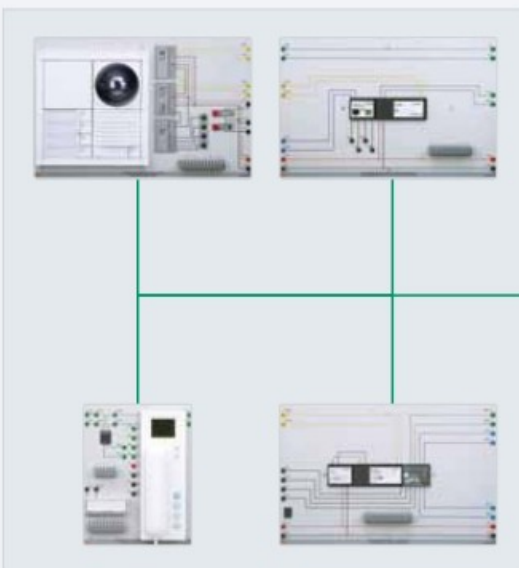
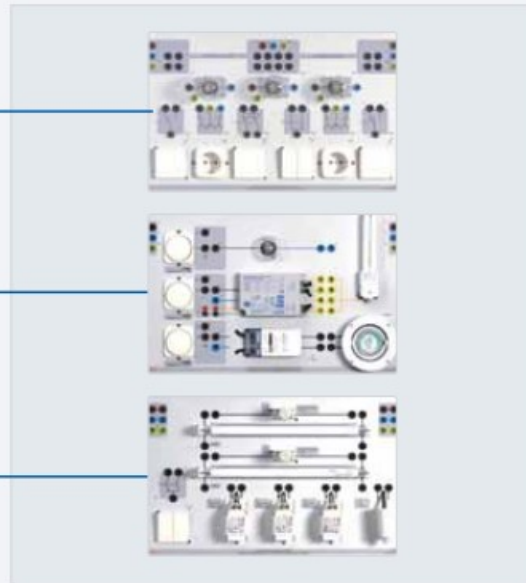
- Charge supplémentaire par asymétrie
- Charge supplémentaire par non linéarité
- Technique d'éclairage non linéaire
- Dangers émanant des surcharges
- Qualité de réseau

Technique d'installation conventionnelle

Signalisations domestiques



Circuits de lampes et d'appareils



Bus In-home

Gestion du bâtiment



KNX®/EIB

Technique des télécommunications





Contenus didactiques

- Analyse de plans d'installation
- Circuits de lampes
(circuits de sectionneurs, d'interrupteurs en série, d'interrupteurs va-et-vient et d'inverseurs avec et sans prise de terre)
- Circuits de lampes fluorescentes (circuits d'interrupteurs, de sectionneurs, d'interrupteurs en série, duo et tandem)



Contenus didactiques

- Installation de sonnerie et de gâche d'ouverture pour un participant

Les exigences à l'égard de l'installation électrique domestique croissent au fur et à mesure que progressent les connaissances techniques. L'installateur doit suivre cette évolution. La technique d'installation KNX® / EIB se base sur la technique d'installation conventionnelle, mais présente une voie nouvelle dans la gestion du bâtiment. Un système de bus supplémentaire doit compléter le réseau d'installation normal pour établir la communication entre les terminaux. Toutes les bornes terminales possèdent leur propre intelligence et sont programmées avec un PC. Il s'agit d'un système décentralisé qui ne requiert l'emploi du PC que pour la programmation.



Contenus didactiques

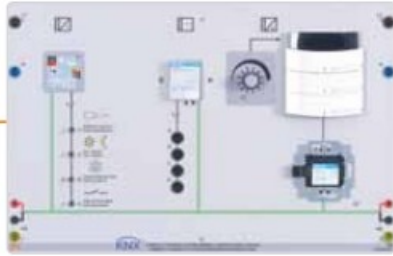
- Bases du bus d'installation KNX®/EIB
- Préparation et structure d'un projet KNX®/EIB
- Programmation d'une mise hors circuit
- Programmation d'un circuit va-et-vient
- Intégration d'interrupteurs conventionnels à un projet KNX®/EIB
- Programmation d'une fonction centrale
- Commutation et variation de lampes
- Commande de stores et de rideaux



Complément EIT 8.2 : Installation de surveillance

Contenus didactiques

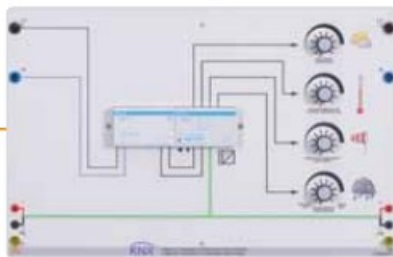
- Surveillance de pièces
- Emploi de l'écran d'information
- Evaluation des messages
- Bouton poussoir Triton KNX®/EIB triple, avec écran
- Détecteur de mouvement et de présence KNX®/EIB
- Interface à bouton poussoir KNX®/EIB
- Contacts de commutation pour fenêtres, portes et verrous



Complément EIT 8.3 : Commande du chauffage

Contenus didactiques

- Commande du chauffage pour la température ambiante
- Commande du chauffage avec réglage antigel
- Réaction du régulateur de température ambiante à des grandeurs perturbatrices
- Adaptation automatique été / hiver
- Contrôle de présence



Complément EIT 8.4 : Station météo

Contenus didactiques

- Acquisition de données météo par le biais de capteurs
- Alimentation des capteurs
- Traitement électrique de valeurs analogiques avec KNX®/EIB
- Evaluation et affichage de signaux analogiques



Complément EIT 8.5 : Couplage de lignes et de zones

Contenus didactiques

- Extension d'une topologie de ligne simple à une topologie de zone
- Alimentation complémentaire de différentes zones et lignes
- Intégration de participants supplémentaires
- Intégration d'interfaces de programmation USB supplémentaires



Complément EIT 8.6 : Commander et visualiser

Contenus didactiques

- Mise en service d'un écran tactile
- Programmation de l'écran tactile
- Représentation graphique sur l'écran tactile

Équipements complémentaires à FIT 8.1

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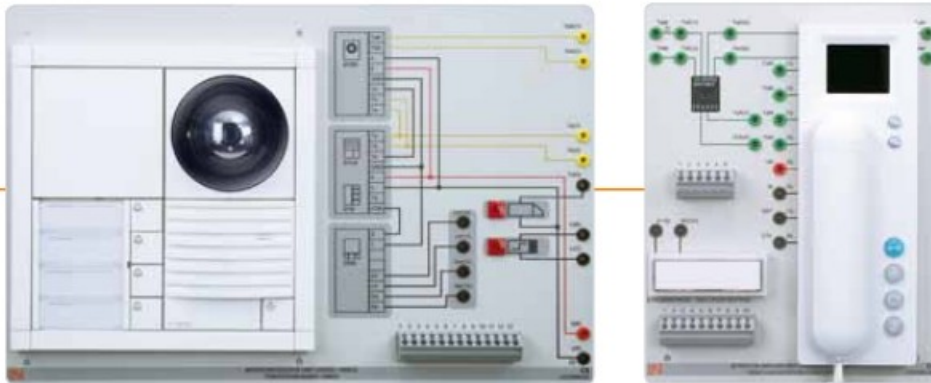
Communication dans le bâtiment

Le système vidéo domestique à commande par bus offre une qualité nouvelle en matière de communication dans le bâtiment. Celle-ci réunit de nombreuses fonctions (voir, entendre, allumer / éteindre la lumière, ouvrir la porte, sonner) tout en minimisant le câblage requis. Combiné à d'autres domaines de la technique d'installation et de communication, le système vidéo domestique peut couvrir d'importants projets de formation. Des installations complexes sont réparties en plusieurs domaines pour réduire le volume des données sur les lignes d'informations. Pour ce domaine, les signaux vidéo et audio sont répartis au choix.



Contenus didactiques

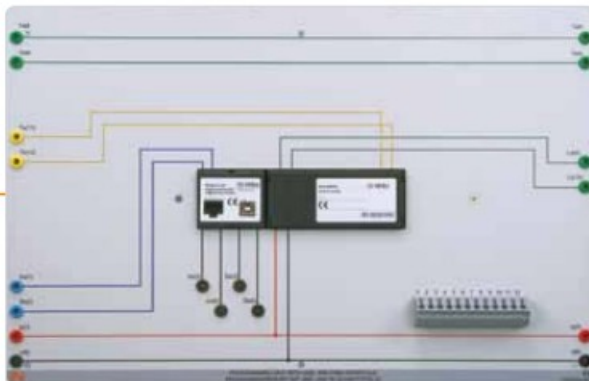
- Structure et programmation d'un interphone d'intérieur en technique de bus
- Dispositif d'interphone à commande vocale entre l'appartement et la porte
- Emploi de différents téléphones intérieurs
- Intégration d'une gâche d'ouverture
- Commande de l'éclairage d'escalier



Complément EIT 9.2 : Communication vidéo

Contenus didactiques

- Structure et programmation d'un interphone vidéo en technique de bus
- Extension d'un interphone audio en interphone vidéo
- Intégration d'une caméra vidéo
- Intégration de plusieurs composants vidéo via distributeur vidéo

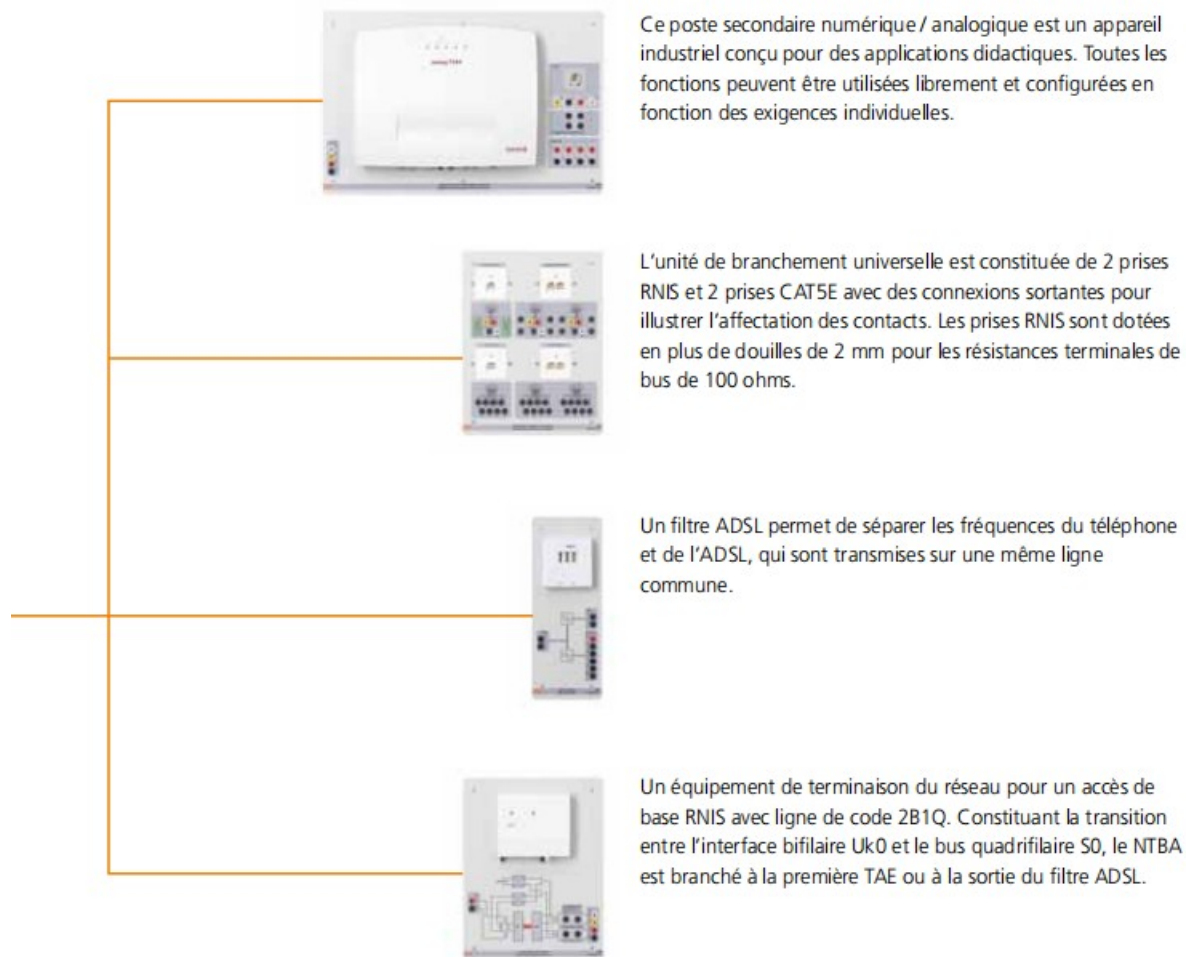


Complément EIT 9.3 : Interface pour réseaux de communication

Contenus didactiques

- Intégration de l'interphone audio dans un PABX existant
- Mise en oeuvre de fonctions de commande via un téléphone
- Mise en service et recherche d'erreurs avec un PC
- Paramétrage des fonctions de service sur le PC





Au choix avec téléphone analogique, VoIP ou RNIS



Commutation manuelle en circuit triphasé

Des consommateurs multipolaires peuvent être commutés directement dans le circuit triphasé jusqu'à une classe de puissance déterminée. Il s'agit d'utiliser correctement l'appareil de commutation adéquat en fonction de l'application. Le développement de circuits ainsi que le choix des éléments de commutation et d'appareils sont au cœur de cette partie de la formation. Les thèmes couvrent par ex. le circuit étoile-triangle, le circuit d'inversion en étoile-triangle ou la commutation de pôles.



Circuits à contacteurs dans un circuit triphasé

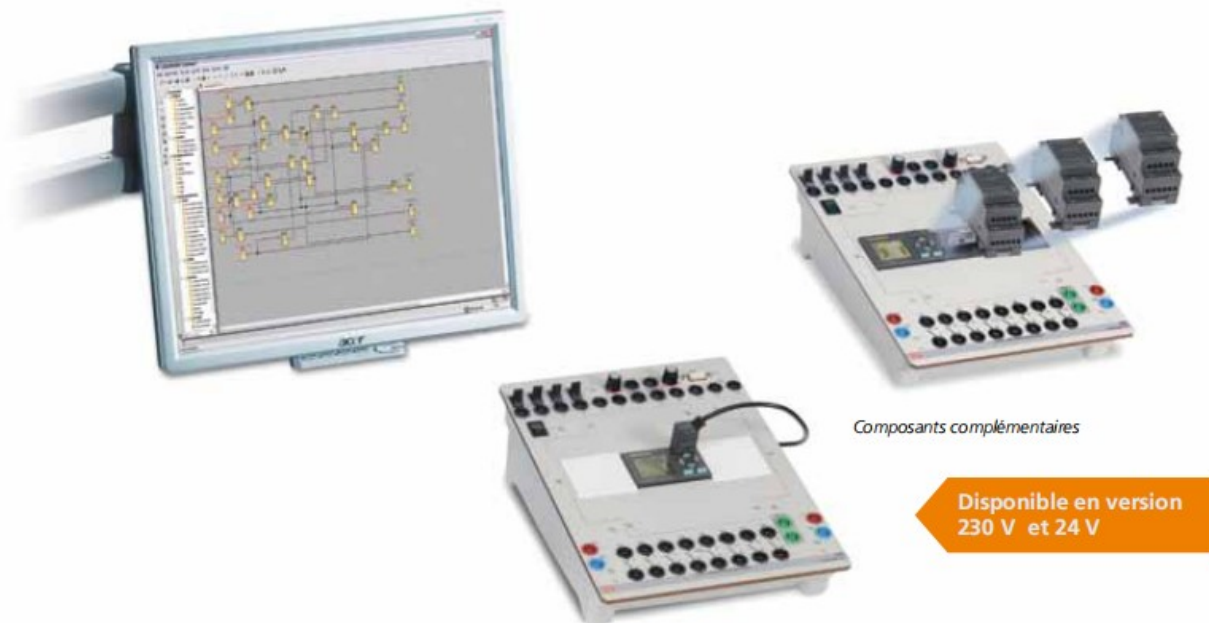
À partir d'une certaine classe de puissance, une commutation directe de consommateurs triphasés n'est plus possible. Aussi ces consommateurs sont-ils activés indirectement par des circuits à contacteurs des types les plus divers. Le développement de la commande et la configuration avec un contrôle du fonctionnement constituent l'objet principal de la formation. Ces Equipements complémentaires permettent de traiter d'importantes fonctions de commande supplémentaires. L'Equipement de machines comprend tous les appareils et machines requis pour expérimenter la commande directe et indirecte de moteurs dans un circuit triphasé.



Contenus didactiques

- Réalisation du schéma des connexions
- Circuit à contacteurs à auto-maintien
- Relais temporisé à l'ouverture et à la fermeture
- Commande réversible à contacteurs avec verrouillages
- Planification, construction et mise en service de commandes complexes
- Fonctionnement et affectation des bornes de connexion
- Contrôle du fonctionnement et recherche d'erreurs

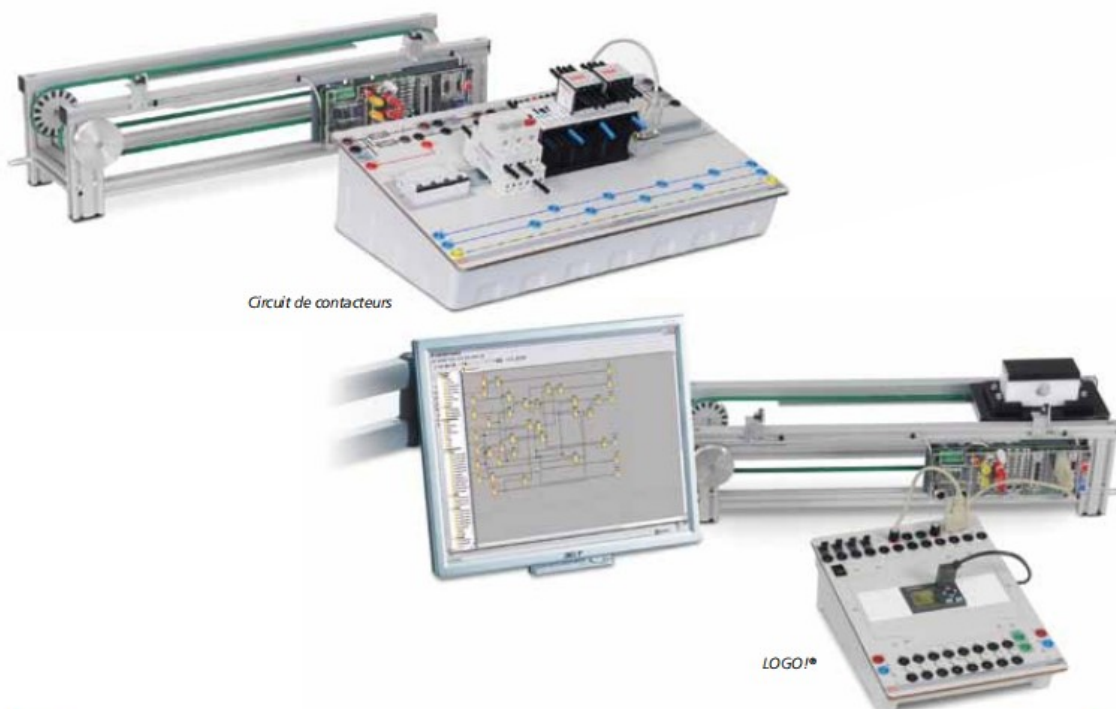
Les petits appareils de commande programmables destinés à l'automatisation industrielle et des bâtiments, tels le module logique LOGO!, permettent de remplacer de nombreux appareils de commutation conventionnels, comme les relais, contacteurs auxiliaires et minuteries. Outre les fonctions logiques de base, plus de vingt fonctions spéciales (interrupteur de l'éclairage d'escalier, compteur d'heures de service, relais à impulsion et minuteries) sont disponibles. Les bases de la programmation de petites commandes reposent sur la technique de commande classique et la technique numérique. La programmation s'effectue soit sur le clavier intégré, soit sur le PC via l'interface intégrée.



Contenus didactiques

- Connexion de modules logiques
- Réalisation du schéma des connexions dans le diagramme fonctionnel
- Programmation des fonctions de base
- Programmation des fonctions spéciales
- Tâches de commande plus complexes
- Test des fonctions

Grâce aux circuits de contacteurs, la technique de commandes câblées convient idéalement aux petits projets réalisés sur la bande transporteuse IMS®. Même les projets avec LOGO!® s'intègrent sans problème et élargissent la gamme des systèmes de commande potentiels. Nos conseillers se tiennent volontiers à votre disposition pour vous fournir de plus amples informations.



Contenus didactiques

• Circuit de contacteurs

- Technique de commande câblée conventionnelle
- Initiation grâce à des exercices simples
- Extension à des projets de commande plus complexes
- Préparation et transfert de projets de commande dans la technique de commande programmée

• LOGO!®

- Premiers pas dans la technique de commande programmée
- Combinaison et extension des exercices de commande existants
- Emploi de LOGO!® Soft-Comfort
- Avec cours multimédia d'autoapprentissage

La mise en oeuvre de sources d'énergie renouvelables dans les installations de de bâtiments résidentiels mais aussi d'immeubles commerciaux et industriels gagne sans cesse en importance. Nous proposons une série de systèmes didactiques, décrits en détail dans le catalogue consacré aux techniques d'énergie électrique.



Equipement EPH 2

Contenus didactiques

- Mise en place d'installations photovoltaïques (PV)
- Structure et test d'une installation PV avec alimentation réseau
- Mesure de l'énergie produite par une installation PV
- Etude du comportement d'une installation PV en cas de panne de secteur
- Structure et test d'une installation PV autonome en mode direct ou avec batterie
- Recherche de l'orientation optimale des modules solaires
- Relevé de caractéristiques des modules solaires
- Etude du comportement en cas d'ombrage
- Types de circuits des modules solaires



Équipement EWG 2

Contenus didactiques

- Structure et fonctionnement de petites centrales éoliennes modernes
- Bases physiques « Du vent à l'arbre mécanique »
- Différents concepts d'éoliennes
- Structure et mise en service de l'alternateur d'une petite centrale éolienne
- Fonctionnement avec différentes forces de vent avec batterie
- Accumulateur d'énergie et optimisation du système



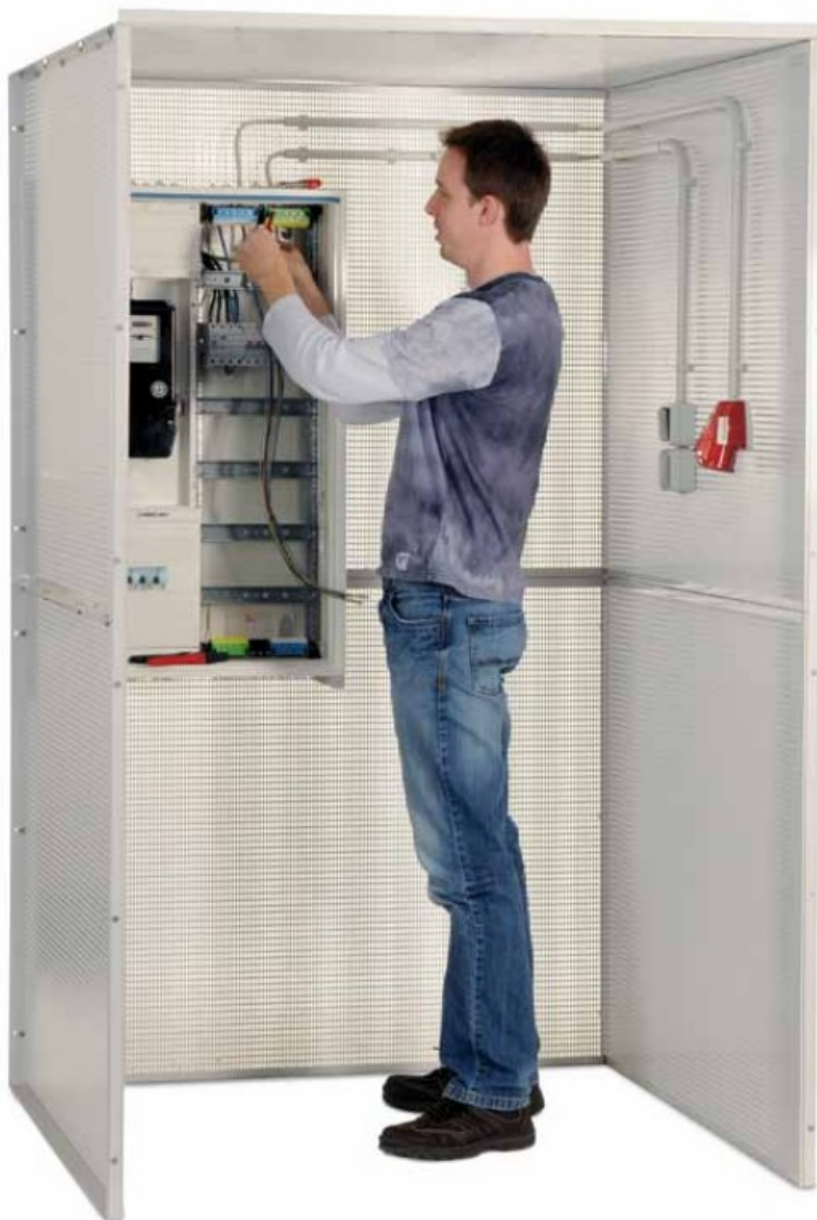
Équipement EHY 1

Contenus didactiques

- Structure et fonctionnement d'une pile à combustible
- Structure et fonctionnement d'un électrolyseur
- Structure et fonctionnement d'un réservoir à hydrure métallique
- Caractéristique et courbe de puissance de la pile à combustible
- Système requis pour une alimentation électrique autonome



Mettant en avant les capacités manuelles tous les exercices de montage ont une très forte connotation pratique. Les raccordements sont réalisés avec du matériel de câblage conventionnel (boîtes de dérivation, colliers de câbles, tubes vides, etc.) et à l'aide de différentes méthodes de câblage. Mis à part le matériel consommable (câbles), toutes les pièces peuvent être réutilisées. Les composants sont fixés aux grilles soit avec des chevilles en plastique, soit avec des jeux de fixation spéciaux.







Reliés au matériel pratique, ces systèmes permettent la réalisation rapide des circuits et des mesures. Les cadres en tôle perforée sont fabriqués en tôle d'acier de 1,5 mm thermolaquée.

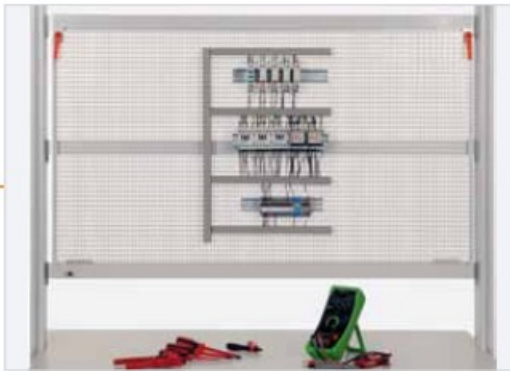


Vos avantages

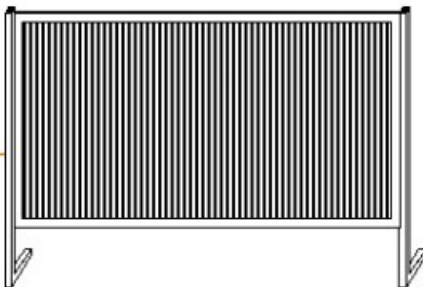
- Planification et réalisation de projets
- Apprentissage des techniques de connexion
- Lien étroit avec la pratique grâce à une documentation et un logiciel techniques proches de la pratique
- Réalisation des circuits à l'aide de composants industriels
- Documentation complète des projets



Les panneaux en tôle perforée à accrocher sont placés entre les rainures des profils des cadres d'expérimentation, permettant ainsi un travail combiné avec des plaques d'expérimentation au format A4 et des cadres en tôle perforée avec du matériel d'installation.



La technique de panneaux interchangeables permet d'utiliser des panneaux en tôle perforée, simplement accrochés devant les cadres en profilé d'aluminium, garantissant un changement rapide entre les plaques d'expérimentation et le panneau en tôle perforée.



Le cadre en tôle perforée sur pied est disponible en plusieurs versions. Pour le montage sur la table, il possède un pied en L et, comme châssis de table, un pied en T. Des modèles avec profil du bas surélevé, pour le montage au-dessus d'un canal d'alimentation, sont également disponibles.



La cabine d'installation sert de support aux projets de montage dans un environnement proche de la pratique.

La structure et les dimensions sont choisies pour permettre aux apprenants de travailler sans risquer de se blesser, malgré la complexité des tâches (installation au plafond, en coin, etc.).

Technique d'installation domestique

Exemple de projet d'apprentissage : La cage d'escalier d'un immeuble à plusieurs étages doit être éclairée par plusieurs lampes et commandée par une minuterie à relais temporisé. À chaque étage se trouve un bouton poussoir. Dans la cave, les lampes standards sont remplacées par des lampes fluorescentes. En outre, deux prises de courant, actionnables depuis deux points différents, doivent être installées dans la cave.



Contenus didactiques

- Exercices d'isolation
- Circuit à interrupteur (en utilisant des tubes de câble)
- Montage à télérupteur avec prise
- Fonctions et emploi de coupe-circuits automatiques
- Techniques de pose de câbles ou de tubes pour les installations apparentes et encastrées
- Contrôle et mise en service des circuits d'après les schémas
- Réalisation de circuits dans une installation avec ou sans tubes de câble pour les lampes fluorescentes
- Circuit à interrupteur et duo avec lampe fluorescente et prise
- Circuit tandem avec lampe fluorescente et prise
- Pliage de fils de fer et de crampons et exercices de câblage
- Circuits en série, va-et-vient et permutateur avec prise
- Minuterie pour éclairage d'escalier avec relais temporisé

Signalisations domestiques

Exemple de projet d'apprentissage : Une maison à deux étages doit être équipée d'une installation de communication domestique. Elle doit comprendre un dispositif de communication avec la porte et deux interphones aux différents étages. Le câblage doit être apparent et réalisé en technique à tubes.



Installations de branchement domestiques

Exemple de projet d'apprentissage : Une construction neuve doit être équipée d'un boîtier de raccordement domestique avec compteur d'énergie. Il est indispensable de respecter les prescriptions en vigueur. La protection doit être assurée par des fusibles, des coupe-circuits automatiques et des disjoncteurs différentiels.



Technique d'installation de réseaux

Exemple de projet d'apprentissage : Il s'agit de moderniser une installation de télécommunication dans un bâtiment ancien. Le poste secondaire doit pouvoir être branché tant à une prise analogique que RNIS. De plus, un portier et plusieurs postes secondaires doivent être intégrés.

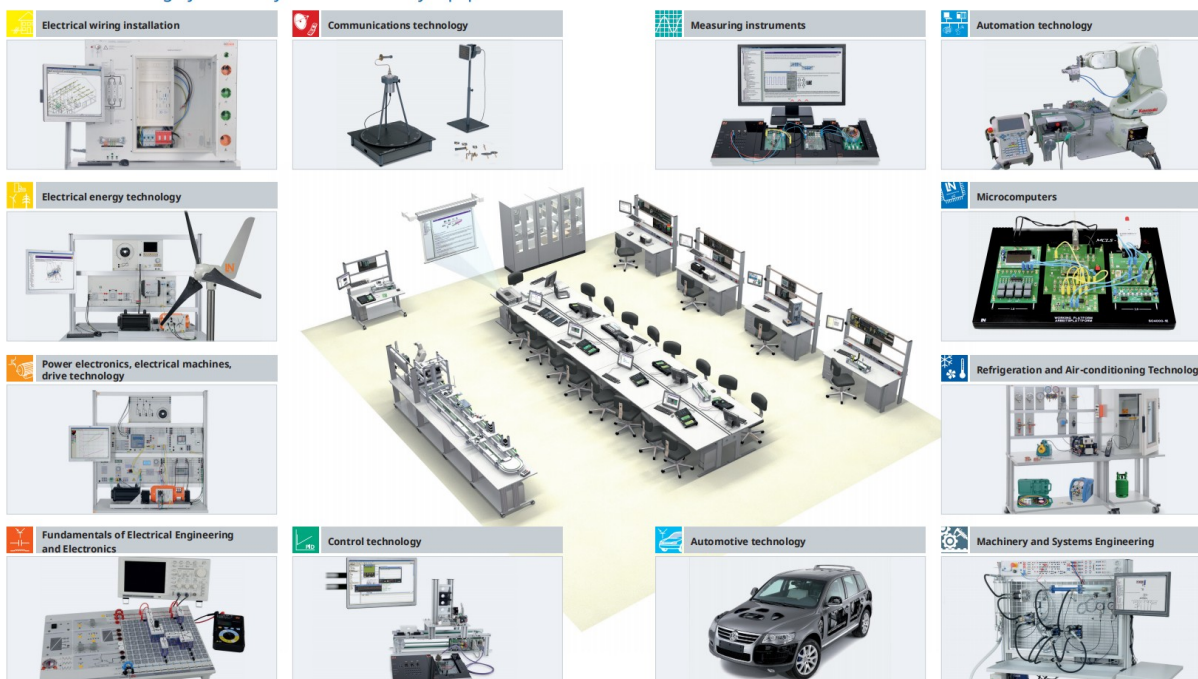


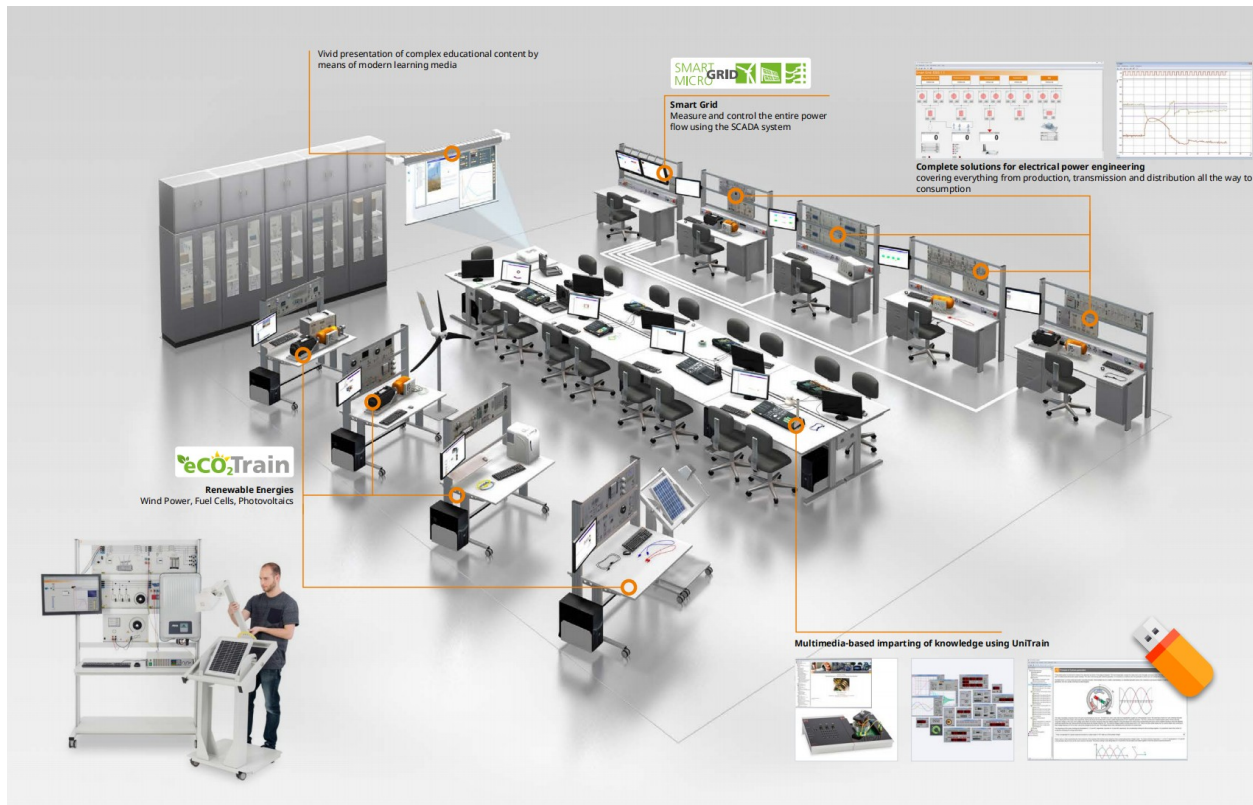
Technique de commande

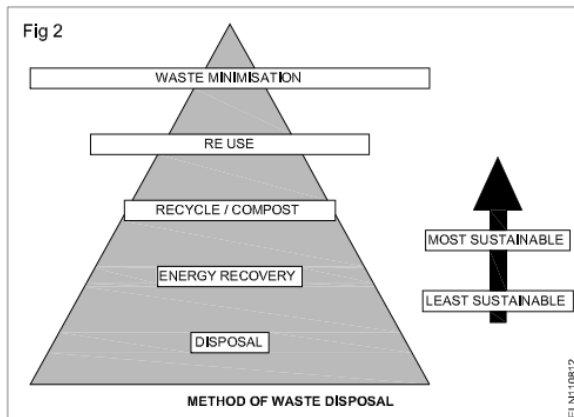
Mettant en avant les capacités manuelles, tous les exercices de montage ont une très forte connotation pratique. Le syst d'apprentissage « Exercice de montage Installations de commutation » offre aux apprenants une approche très réaliste c et du câblage de composants industriels. L'emploi de composants industriels type augmente le lien étroit avec la pratique possible de monter et de tester différents projets industriels type.



Lucas-Nülle Training Systems + SybaLab Laboratory Equipment = **Guaranteed Educational Success**







- Landfill
- Incineration
- Waste compaction
- Reuse
- Animal Feed
- Fire Wood

Recycling

Recycling is one of the most well known method of managing waste. It is not expensive and can be easily done by you. If you carry out recycling, you will save a lot of energy, resources and thereby reduce pollution.

Composting

This is a natural process that is completely free of any hazardous by-products. This process involves breaking down the material into organic compounds that can be used as manure.

Landfill

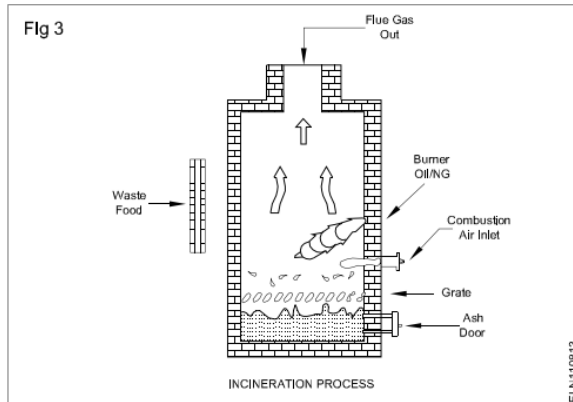
In this process, the waste cannot be reused or recycled separated out and spread as a thin layer in some low-lying areas across the city. A layer of soil added after each layer of garbage. Once this process is complete, this area declared unfit for building construction and is only used as a playground or a park.

Incineration (Fig 3)

It is the process of controlled combustion of garbage to reduce it to incombustible matter, ash, waste gas and heat. It is treated and released into the environment (Fig 3). This reduced 90% volume of waste some time

Waste compaction

The waste materials such as cans and plastic bottles compact into blocks and send for recycling. This process need space, thus making transportation and positioning difficult.



Reuse

The amount of waste disposal can be reduced by carefully considering the exact throwing away. Before discarding the item think for the possibility to wash and reuse them. Plastic tubs contents butter or icecream can become effective storage containers for a range of small item like nails or screws.

Animal Feed:

Vegetable peel and food scraps can be retained to feed small animals such as lamsters rabbit etc. Large meat bones will be greatly reused by feeding dog.

Fire Wood:

A small amount of waste disposal can be reused when it comes to refurbishing have or replacing furniture. before discarding the furniture, cut it into more meaningful process and use as fire wood.

Electrician - Safety Practice and Hand Tools

Trade hand tools - specification - standards - NEC code 2011 - lifting of heavy loads

Objectives: At the end of this lesson you shall be able to

- list the tools necessary for an electrician
- specify the tools and state the use of each tool
- explain the care and maintenance of electrician hand tools.

It is important that the electrician uses proper tools for his work. The accuracy of workmanship and speed of work depend upon the use of correct tools. If the tools are properly used, and maintained, the electrician will find the working efficiency increases and the skills becomes a work habit.

Listed below are the most commonly used tools by electrician.

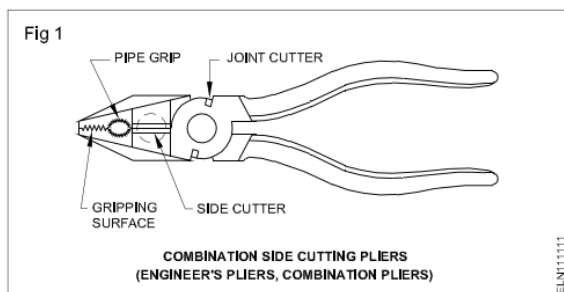
Their specifications and BIS number are given for your reference. Proper method of care and maintenance will result in prolonged tool life and improved working efficiency.

Pliers

They are specified with their overall dimensions of length in mm. The pliers used for electrical work will be of insulated grip.

1 Combination pliers with pipe grip, side cutter and insulated handle. BIS 3650 (Fig 1)

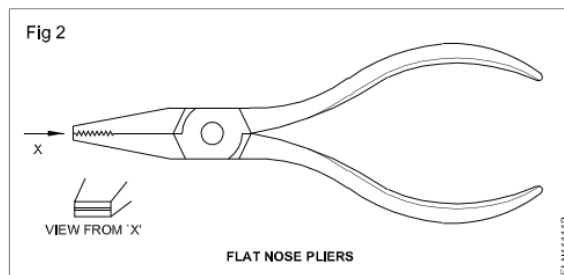
Size 150 mm, 200 mm etc.



It is made of forged steel. It is used for cutting, twisting, pulling, holding and gripping small jobs in wiring assembly and repairing work. A non-insulated type is also available. Insulated pliers are used for work on live lines.

2 Flat nose pliers BIS 3552 (Fig 2)

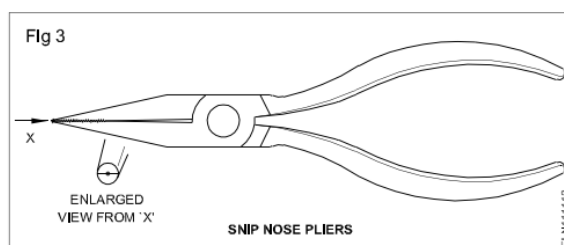
Size 100 mm, 150 mm, 200 mm etc.



Flat nose pliers are used for holding flat objects like thin plates etc.

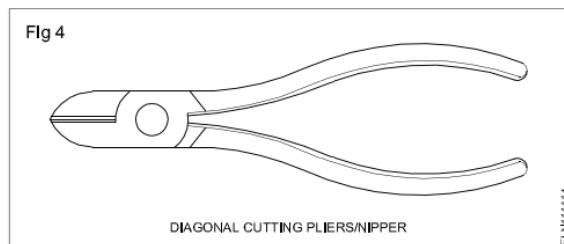
3 Long nose pliers or (snip nose pliers) with side cutter. BIS 5658 (Fig 3)

Size 100 mm, 150 mm etc.



Long nose pliers are used for holding small objects in places where fingers cannot reach.

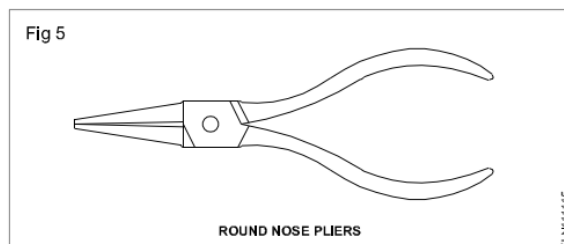
4 Side cutting pliers (Diagonal cutting pliers) BIS 4378 (Fig 4) Size 100 mm, 150 mm etc.



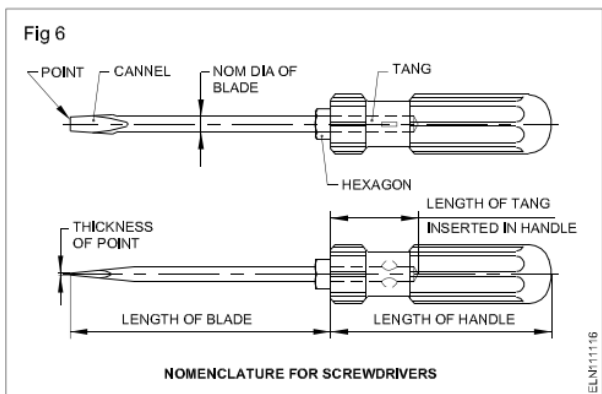
It is used for cutting copper and aluminium wires of smaller diameter (less than 4mm dia).

5 Round nose pliers BIS 3568 (Fig 5)

Size 100 mm, 150 mm etc.



Wire hooks and loops could be made using the round nose pliers.



The screwdrivers used for electrical works generally have plastic handles and the stem is covered with insulating sleeves. The size of the screw driver is specified by its blade length in mm and nominal screwdriver's point size (thickness of tip of blade) and by the diameter of the stem.

- eg. 75 mm x 0.4 mm x 2.5 mm
150 mm x 0.6 mm x 4 mm
200 mm x 0.8 mm x 5.5 mm etc.

The handle of screwdrivers is either made of wood or cellulose acetate.

Screwdrivers are used for tightening or loosening screws. The screwdriver tip should correctly fit the grooves of the screw to have maximum efficiency and to avoid damage to the screw heads.

As the length of the screw driver is proportional to the turning force, for small work choose a suitable small sized screwdriver and vice versa.

Star-head Screwdriver

It is used for driving star headed screws.

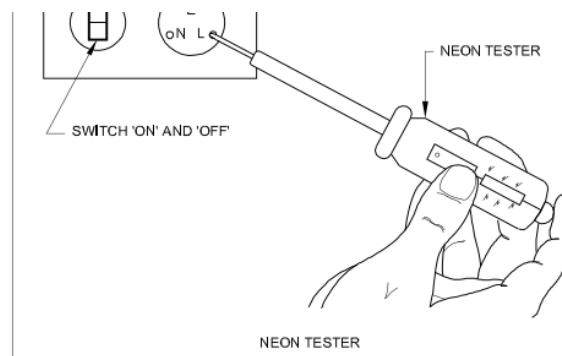
Care and maintenance

- Never use a screwdriver as a lever to apply force as this action will make the stem to bend and the use of the screw driver will be lost.
- Keep the tip in correct shape and in rare cases it could be grinded to shape.

7 Neon tester BIS 5579 - 1985 (Fig 7)

It is specified with its working voltage range 100 to 250 volts but rated to 500 V.

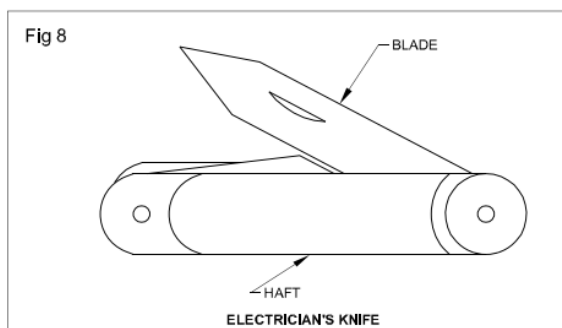
It consists of a glass tube filled with neon gas, and



Care and maintenance

- Never use the neon tester for voltage higher than specified range.
- While testing see the circuit is completed through body. In case if you are using rubber soled shoes, earthing of the body could be provided by touching wall by one hand.
- Use the screwdriver tipped neon tester for light d work only.

8 Electrician's knife (Double blade) (Fig 8)



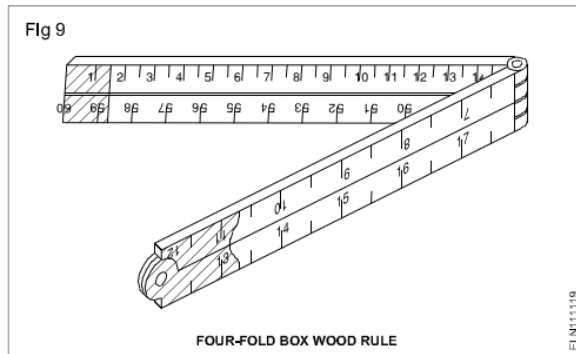
The size of the knife is specified by its largest blade len eg. 50 mm, 75 mm.

It is used for skinning the insulation of cables and clear the wire surface. One of the blades which is sharp is u: for skinning the cable and the rough edged blade is u: for cleaning the surface of the wires.

Care and maintenance

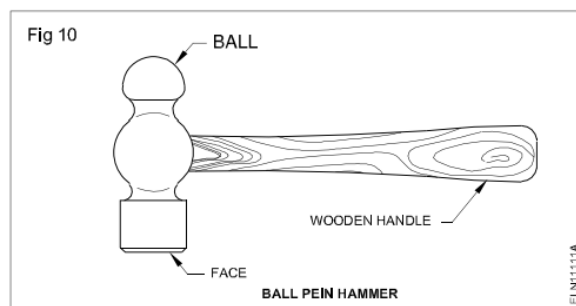
- Do not use the knife for cutting wires.
- Keep it free from rust.
- Keep one of the blades in a sharp condition.
- Fold the knife blade when not in use.

9 Four-fold box wood rule 600mm (Fig 9)



Used for measuring short lengths. To be kept in folded condition when not in use.

10 Hammer ball pein (Fig 10)



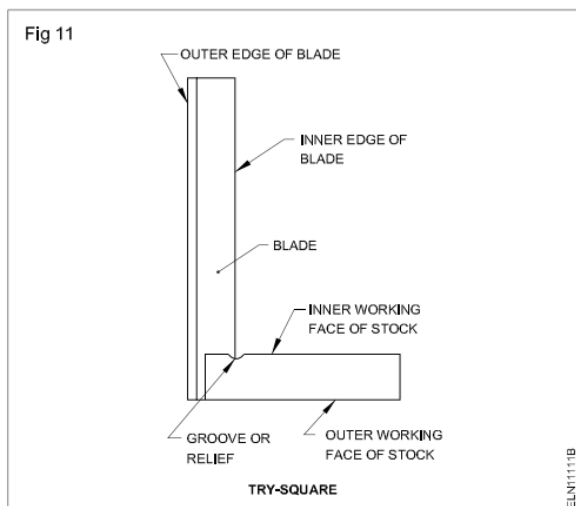
The size of the hammer is expressed in weight of the metal head. Eg. 125 gms, 250 gms etc.

The hammer is made out of special steel and the striking face is tempered. Used for nailing, straightening, and bending work. The handle is made of hard wood.

Care and maintenance

- Do not use a hammer with a loose handle.
- The face of the hammer must be free from oil, grease and mushrooms.

11 Try-square (Engineer's square) (Fig 11) BIS 2103



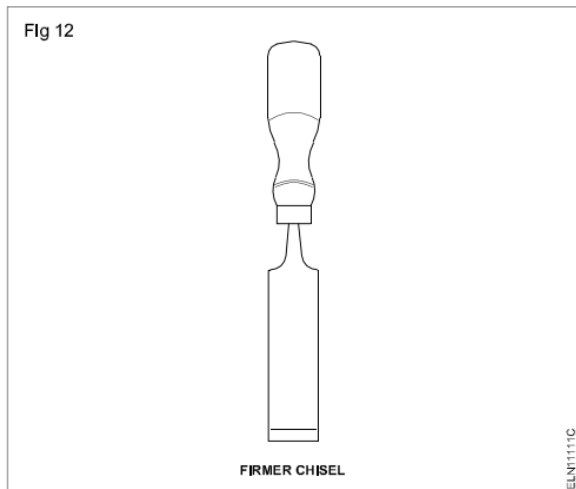
This is specified by its blade length.

- Eg.
- 50 mm x 35 mm
 - 100 mm x 70 mm
 - 150 mm x 100 mm etc.

There are two types; one is the bevelled edge with stock and the other is the flat edge without stock. It is used to check whether the object is plane, perpendicular and at right angle. Two straight blades set at right angles to each other constitute the try-square. The steel blade is riveted to the stock. The stock is made of cast iron. The stock should be set against the edge of the job.

Do not use it as a hammer.

12 Firmer chisel (Fig 12)

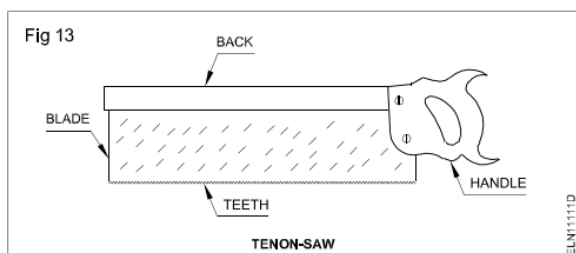


It has a wooden handle and a cast steel blade of 150 mm length. Its size is measured according to the width of the blade eg. 6 mm, 12 mm, 18 mm, 25 mm. It is used for chipping, scraping and grooving in wood.

Care and maintenance

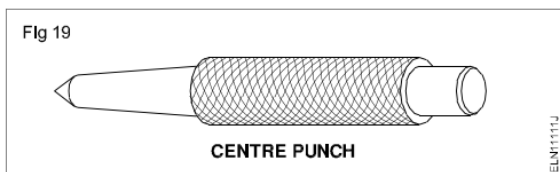
- Do not use it for driving screws.
- Use mallet for chiseling.
- Grind on a water stone and sharpen on an oilstone.
- Do not use it in places where nails are driven.

13 Tenon-saw (Fig 13) BIS 5123, BIS 5130, BIS 5031



Generally the length of a tenon-saw will be 250 or 300 mm. and has 8 to 12 teeth per 25.4 mm and the blade width is 10 cm. It is used for cutting thin, wooden accessories like wooden batten, casing capping, boards and round blocks.

19 Centre punch (Fig 19) BIS 7177



The size is given by its length and diameter of the body.

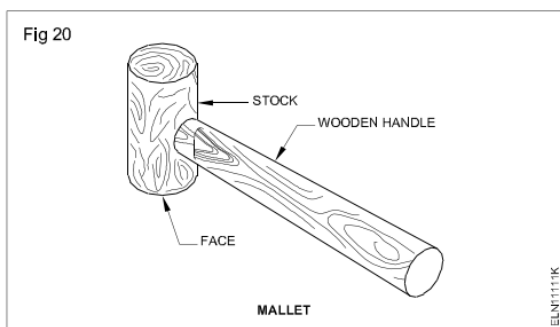
Eg. 100 mm x 8 mm. The angle of the tip of the centre punch is 90°.

It is used for marking and punching pilot holes on metals. It is made of tool steel and the ends are hardened and tempered.

Care and maintenance

- Keep the tip sharp and at a proper angle.
- Avoid mushroom heads.

20 Mallet (Fig 20)



The mallet is specified by the diameter of the head or by the weight.

eg. 50 mm x 150 mm

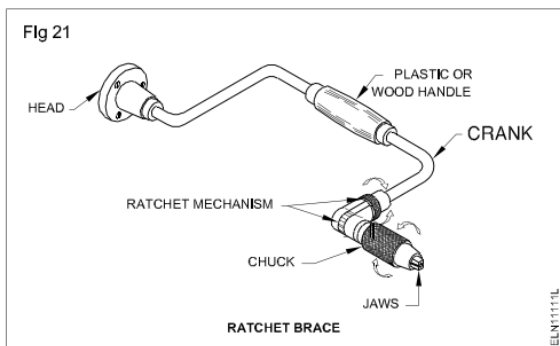
75 mm x 150 mm or 500gms, 1 Kg.

It is made out of hard wood or nylon. It is used for driving the firmer chisel, and for straightening and bending of thin metallic sheets. Also it is used in motor assembly work.

Care and maintenance

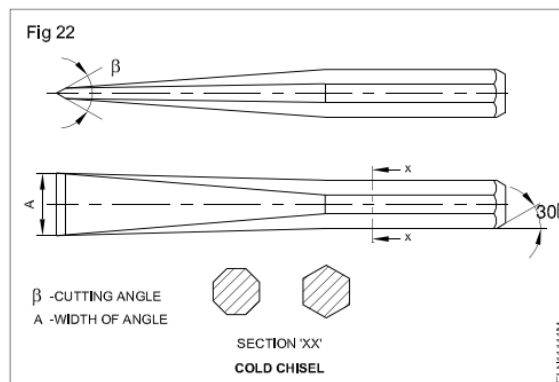
- Do not use it for fixing nails.
- Never use it on hard metal like steel and iron.

21 Ratchet brace (Fig 21) BIS 7042



The size of a ratchet brace is given by the size of drill bit it can accommodate ie. 0 - 6 mm, 0 - 12 mm. It is used to drill holes on wooden blocks.

22 Flat cold chisel (Fig 22) BIS 402



Its size is given by the nominal width and length.

ie. 14 mm x 100 mm

15 mm x 150 mm

20 mm x 150 mm

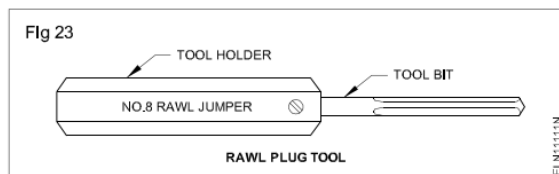
The body shape of a cold chisel may be round or hexagon.

The cold chisel is made out of high carbon steel. Its cutting edge angle varies from 35° to 45°. The cutting edge of the chisel is hardened and tempered. This chisel is used for making holes on wall etc.

Care and maintenance

- The edge of a chisel must be maintained as per the required angle.
- While grinding a chisel apply a coolant frequently so that its temper may not be lost.

23 Rawl plug tool and bit (Fig 23)



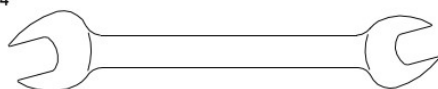
Its size depends upon the number. As the number increases, the thickness of the bit as well as the plug also increases. Eg. Nos. 8, 10, 12, 14 etc.

A rawl plug tool has two parts, namely the tool bit and tool holder. The tool bit is made of tool steel and the holder is made of mild steel. It is used for making holes in bricks, concrete wall and ceiling. Rawl plugs are inserted in them to fix accessories.

Care and maintenance

- Slightly rotate the holder after each hammering stroke.
- Hold the tool straight.
- Do not throw it on the ground.
- Keep its head free from mushrooms.

Fig 24



DOUBLE ENDED OPEN JAW SPANNER

ELN111110

The size of a spanner is indicated so as to fit on the nuts. They are available in many sizes and shapes.

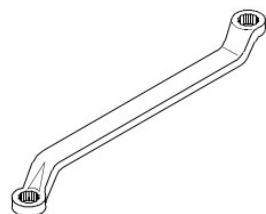
The sizes, indicated in double-ended spanners are

- 10-11 mm
- 12-13 mm
- 14-15 mm
- 16-17 mm
- 18-19 mm
- 20-22 mm.

For loosening and tightening of nuts and bolts, spanner sets are used. It is made out of cast steel. They are available in many sizes and may have single or double ends.

25 Ring spanner set (Fig 25) BIS 2029

Fig 25



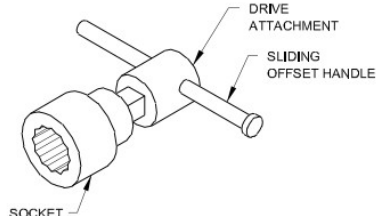
RING SPANNER

ELN11111P

The ring spanner is used in places where the space is restricted and where high leverage is required.

26 Socket (box) spanner (Fig 26) BIS 7993, 7991, 6129

Fig 26



SOCKET SPANNER

ELN11111Q

These spanners are useful at places where the nut or bolt is located in narrow space or at depth.

27 Single ended open jaw adjustable spanner (Fig 27) BIS 6149

It saves time and working. The movable jaw is made adjustable by operating a screw. It is known as a monkey wrench also. Available in 150,200,250mm etc.

- Use correct size spanner suitable to the size of nut and bolt.
- Do not use a spanner as a hammer.
- While using a spanner do not strike it with a hammer.
- Prevent the grease and oil traces on its jaws.

Fig 27

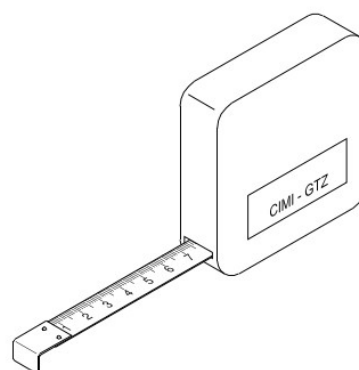


ADJUSTABLE SPANNER

ELN11111R

28 Measuring steel tape (Fig 28)

Fig 28



MEASURING STEEL TAPE

ELN11111S

The size will be the maximum length it can measure. Eg. Blade 12 mm wide 2 metres long.

The measuring tape is made of thin steel blade, bearing dimensions on it.

It is used for measuring the dimension of the wiring installation and general measurements.

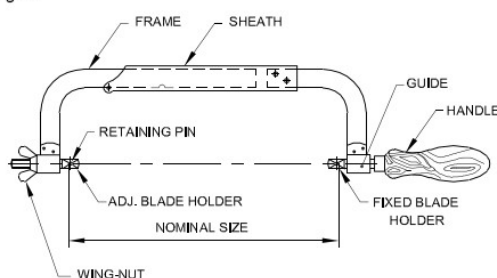
Care and maintenance

Handle with great care as carelessness may spoil the graduation.

29 Hacksaw (Fig 29) BIS 5169-1986 for frames

BIS 2594 - 1977 for blades

Fig 29



NOMENCLATURE FOR HACKSAW FRAME

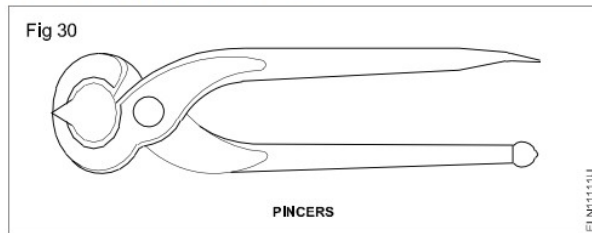
ELN11111T

can be adjusted for 250 mm to 300 mm blades. It should be fixed on the frame with its teeth pointing away from the handle in order to do the cutting in forward stroke. It is mainly used for cutting metals.

Care and maintenance

- The blade should be properly tightened.
- Use a coolant while cutting.
- It should be straight during cutting.
- Lift the saw slightly on the return stroke.
- Do not attempt to saw too fast.

30 Pincers (Fig 30) BIS 4195



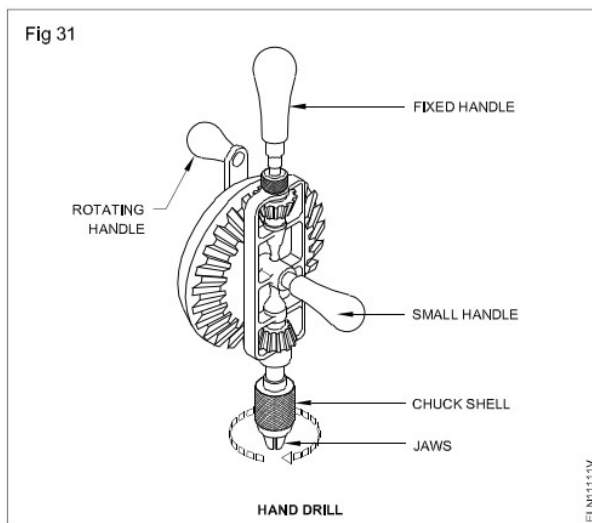
The size is given by its length. Eg. 100 mm, 150 mm, 200 mm.

It is used for extracting nails from the wood.

Care and maintenance

- Do not use it as a hammer.

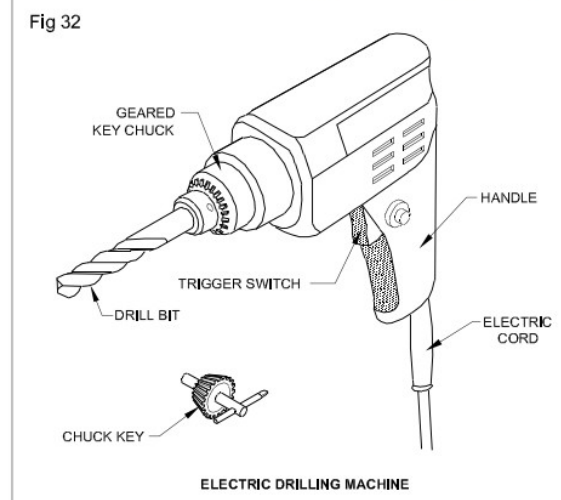
31 Hand drill (Fig 31)



in. Eg. 6 mm, 0-12 mm capacity.

A hand drill machine is used for making holes in thin metal sheets or wooden articles.

32 Portable Electric drilling machine (Fig 32)



When power is available, a power drilling machine is a convenient and accurate tool for drilling holes on wood and metal articles.

Care and maintenance

- Lubricate all the moving parts of the machine.
- Fix the drill bit firmly in the jaws.
- Before drilling, mark the job with a centre punch.
- For taking out the drill bit move the chuck in the reverse direction.
- Do not apply excess pressure on small bits.
- In the case of an electric drilling machine it must be properly earthed and the insulation should be sound.

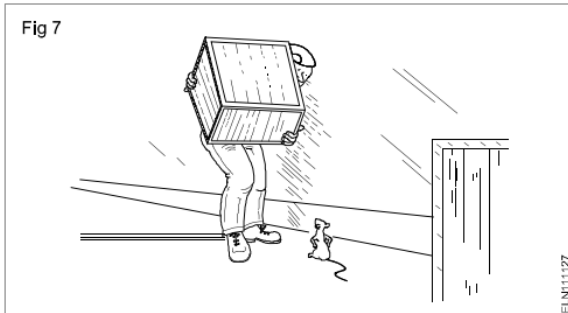
back on the hips slightly (to counter balance the load) before straightening up. (Fig 6)

Keeping the load well near to the body, carry it to the place where it is to be set down. When turning, avoid twisting from the waist - turn the whole body in one movement.

Lowering the load

Make sure the area is clear of any obstructions. (Fig 7)

Bend the knees to a semi-squatting position; keep the back and head erect by looking straight ahead, not down at the load. It may be helpful to rest the elbows on the thighs during the final stage of lowering.



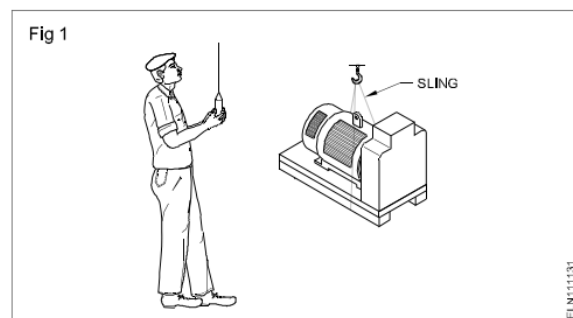
Moving heavy equipment

Heavy equipments are moved in industry using any of the following methods.

- Crane and slings
- Winches
- Machine moving platforms
- Layers and rollers

Using crane and slings

This method is used whenever loads are to be lifted and moved. (Fig 1)



Examine the steel rope sling for any cut, abrasion, wear, fraying or corrosion.

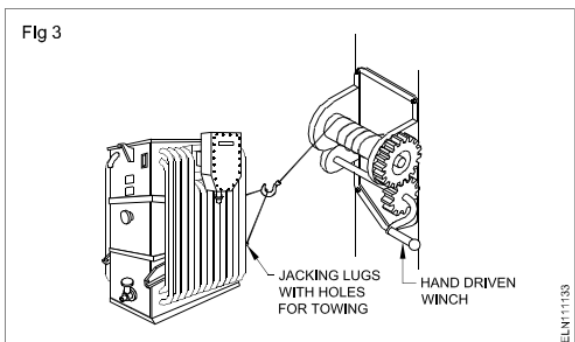
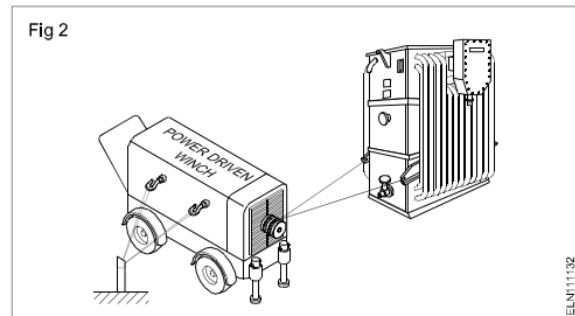
Damaged slings must not be used.

Distribute the weight as evenly as possible between the slings when using more than one sling. (Fig 1)

Keep the slings as near to vertical as possible.

Winches

Winches are used to pull heavy loads along the ground. They may be power-driven (Fig 2) or hand operated. (Fig 3).



Ensure that the safe working load (SWL) of the winch is adequate for the task.

Secure the winch to a structure which is strong enough to withstand the pull.

On open ground, drive long stakes into the ground and secure the winch to them.

Choose a suitable sling and pass it around the base of the load. Secure it to the hook of the winch.

Some heavy items have special lugs welded to them for jacking and towing purposes.

Safety consideration

Before using any winch, check that the brake and ratchet mechanism are in working order. Practise how to use the brakes.

Keep hands and fingers well away from the gear wheels.

Keep the bearings and gears oiled or greased.

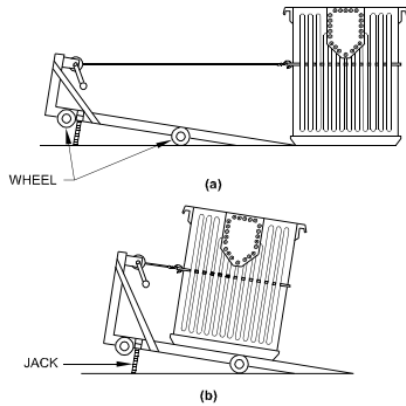
Machine moving platforms

This is a special device made to move heavy equipment in industry. Fig 4 shows the method of loading a heavy transformer.

Pass a suitable sling round the load at a convenient height.

Attach the sling to the hook of the winch and draw the load on the platform until its centre of gravity lies between the front and rear wheels.

Fig 4



Lower the jacks so that the platform rests on its wheels.

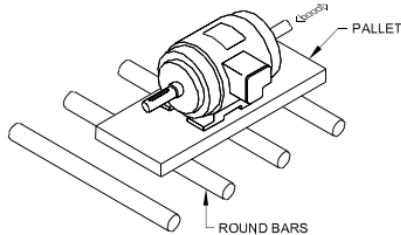
For unloading follow the procedure in the reverse order.

Using layers and rollers

Sometimes a load cannot be moved along the ground because of the irregular shape of its base or because it is not rigid enough.

Place such a load on a flat-bottomed pallet or 'layer' resting on the round bars. (Fig 5)

Fig 5



Ensure the bars (rollers) are long enough to project at each side of the load, for ease of handling.

They should be large enough to roll easily over any uneven surface along the route but should be small enough to be handled easily.

Two or three bars of equal diameter are sufficient for most loads but if four or more are used, the load may be moved faster as there is no delay when moving the rear bar to the front. (Fig 5)

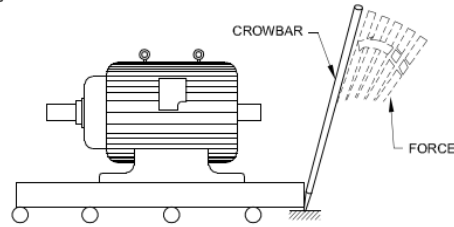
Move the load by using a crowbar as shown in Fig 6. Keep the crowbar at the end of the pallet with an angle and a firm grip on the ground. Apply the force at the top of the bar as shown.

When a load is on rollers, only shallow slopes can be negotiated.

Hold the load in check all the time if it is on the slope.

Use a winch with an effective brake for this operation.

Fig 6

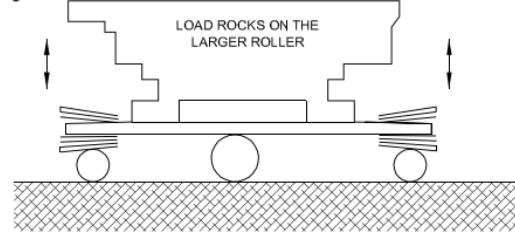


To negotiate a corner on rollers

For a moderate load, insert one roller a little larger in diameter than the others as the corner is approached.

When this roller is under the centre of gravity of the load, the load can be rocked to and fro on the roller and swivelled around sideways. (Fig 7)

Fig 7

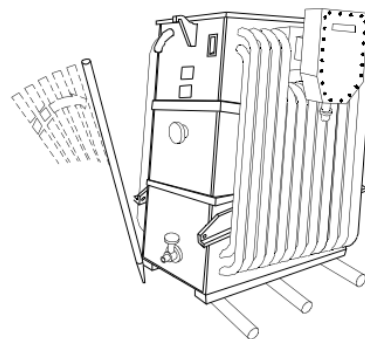


For heavier loads

Stop the load on the roller at the beginning of the corner.

Twist the load round on the rollers by pushing the sides with crowbars until the load is just over the ends of the rollers. (Fig 8)

Fig 8



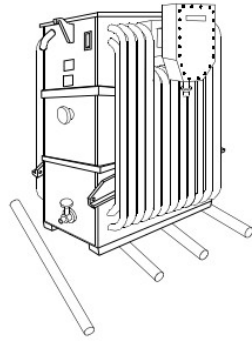
Place some rollers at an angle to the front of the load. (Fig 9)

Push the load forward on to these rollers.

Twist the load further round and place the freed rollers in front of and at an angle to the load.

Continue until the load is pointing in the desired direction.

Fig 9



ELN11139

Safety consideration

Moving heavy loads with crowbars or jacks

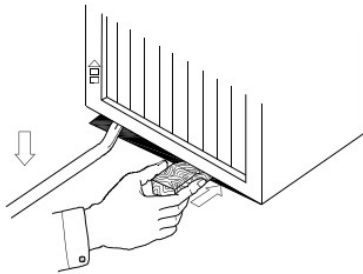
Make sure your hands are clear of the load before lowering it on to the packing or rollers.

Do not use your hands underneath the packing when positioning it. Use a push block.

Place the packing on the floor and push it under the load. (Fig 10)

Hold it by its side faces keeping the fingers well away from the lower edge of the load and from the floor. (Fig 10)

Fig 10



ELN11139A

Raising a load

Check that the slings are correctly secured to the load and to the hook. Ensure they are not twisted or caught on a projecting part of the load.

Before starting to lift a load, if you cannot see an assistant on the far side of the load, verify that he is ready to lift the load and ensure that his hands are clear of the slings.

Warn nearby workers that the lifting is about to begin.

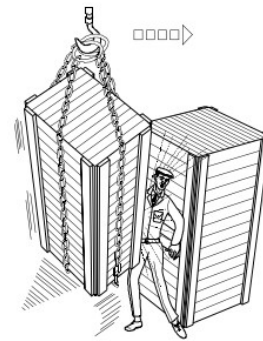
Lift slowly.

Take care to avoid being crushed against other objects as the load rises. (Fig 11) it may swing or rotate as it leaves the ground.

Minimise such movement by locating the hooks as accurately as possible above the centre of gravity of the load.

Keep the floor clear of unnecessary objects.

Fig 11

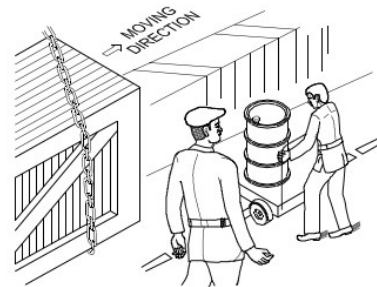


ELN11138

Moving a load

Check that there are no obstacles in the way of the crane and load. (Fig 12)

Fig 12



ELN1113C

Stand clear off the load and move it steadily.

Be prepared to stop the load quickly if somebody moves into its path.

Allow for the natural swing of the load when changing speed or direction.

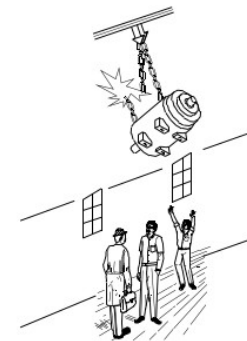
Ensure that the load will not pass over the head of other people. (Fig 13)

The tackle or sling may fall or slip.

Warn other workers to stand clearly away from the route of the load.

Remember that accidents do not happen, they are caused.

Fig 14



ELN1113D

Filing tools - marking tools - specification - grades - uses

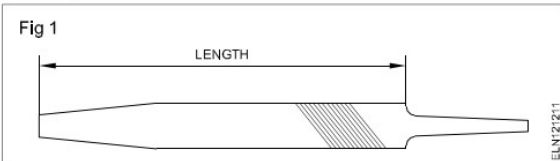
Objectives : At the end of this lesson you shall be able to

- state the different types of files and their grades, shapes, specification and application.
- state the different cuts of files and their uses
- state the parts of file

File : File is a filing tool, which is used to file the rough surface & smooth surface on metals

File specification: Files are specified according to their

- length
- grade
- cut
- shape



Length is the distance from the tip to the heel (Fig 1). It may be 300mm, 250mm, 200mm, 150mm or 100mm.

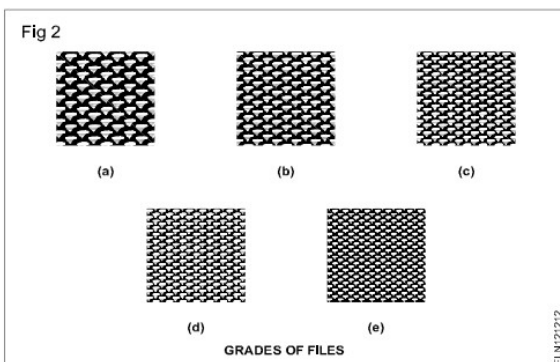
Rough, bastard, second cut, smooth and dead smooth are the different **grades** of files commonly available.

A rough file is used for removing more quantity of metal quickly. (Fig 2a)

A bastard file is used for ordinary filing purposes. (Fig 2b)

A second cut file is used for good finishing purposes. (Fig 2c)

A smooth file is used for removing less metal and for giving good surface finish. (Fig 2d)



A dead smooth file is used for high degree finishing. (Fig 2e)

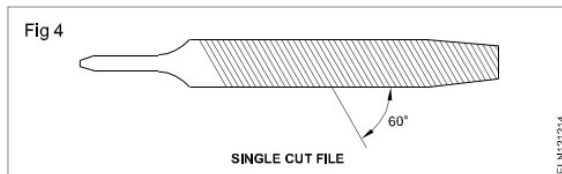
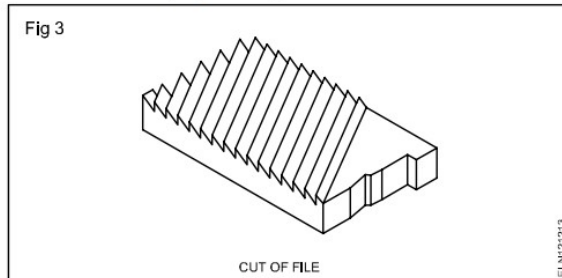
Cut of file: The rows of teeth determine the cut of a file.

Types of cut

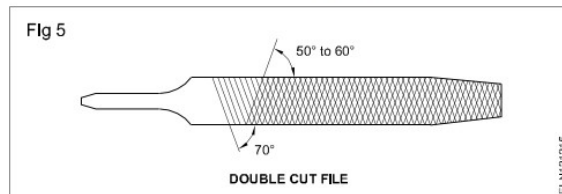
Single cut, double cut, rasp cut and curved cut are the different types of cuts of files.

44

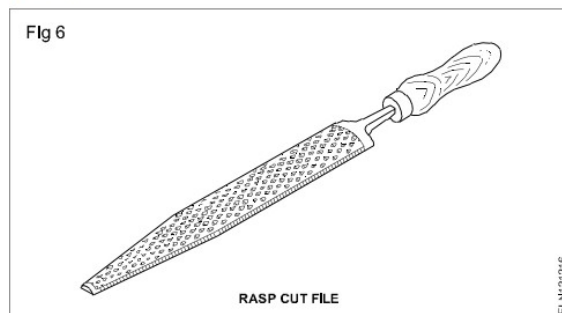
Single cut: A single cut file has a single row of teeth in one direction on the face of the file at an angle of 60° and this file is used for filing soft material such as lead, tin, aluminium etc. (Figs 3 & 4)



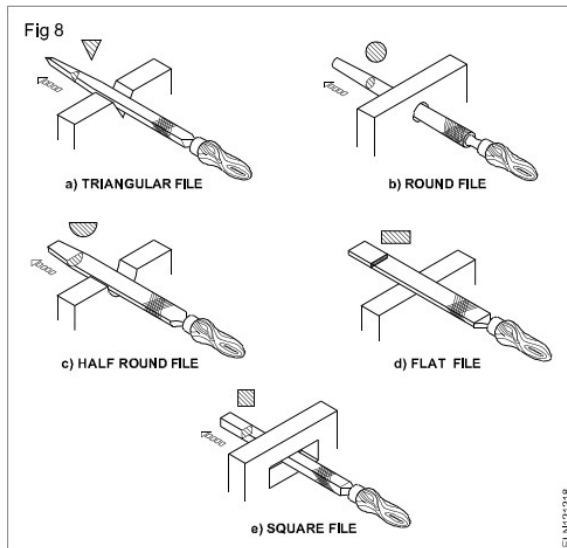
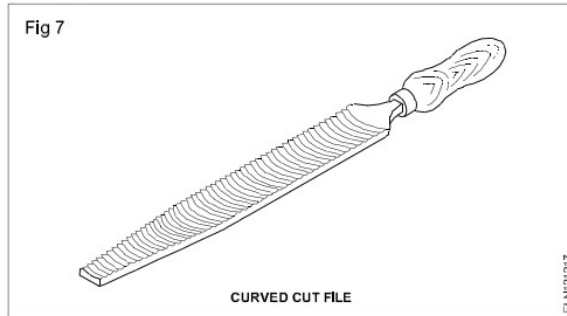
Double cut: A double cut file has rows of teeth in two directions across each other, one at an angle of 50° to 60° , another row at 70° which is used to file hard materials such as steel, brass, bronze, etc. (Fig 5)



Rasp cut: This has individual, sharp, pointed teeth in a line, and is useful for filing wood, leather and other soft materials. These files are available only in half-round shape. (Fig 6)



Curved cut: These files have deeper cutting action, and are useful for filing soft materials like - aluminium, tin, copper and plastic. These are available only in flat shape. (Fig 7)



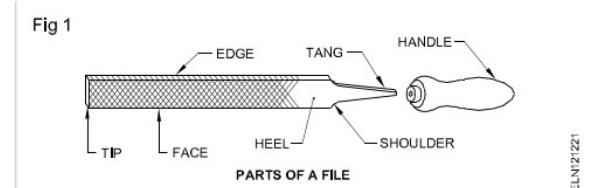
The selection of the type of cut is based on the material to be filed. Single cut files are used for filing soft materials. But certain special files, for example - those used for sharpening saws, are also of single cut.

Shape: The various shapes of files with their application are shown below. The cross-section drawn in the file refers to the shape of the file. (Fig 8)

Parts of file

File : A file is a cutting tool with multiple cutting edges used for filing different materials.

Parts of a file (Refer Fig 1 below)



Tip or point: This is the end of the file opposite to tang.

Face or side: The broad part of the file with teeth cut on it.

Edge: The thin part of the file with a simple row of parallel teeth.

Heel: It is the broad part of the file without teeth.

Shoulder : It is the curved part of a file separating the tang from the body.

Tang: Narrow and thin part of a file which fits into the handle.

Handle: The part fitted to the tang to hold and use the file.

Bench vice

Objectives: At the end of this lesson you shall be able to

- name the parts and state the uses of a bench vice
- specify the size of a bench vice
- state the uses of vice clamps.

Bench vice: Vices are used for holding workpieces. They are available in different types.

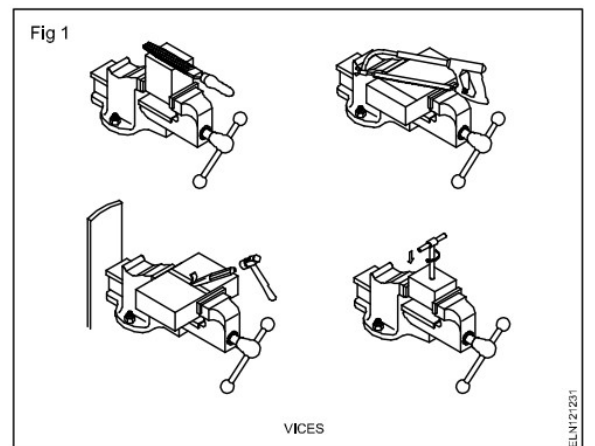
The vice used for bench work is the bench vice (Engineer's vice).

A bench vice is made of cast iron or cast steel, and it is used to hold work for filing, sawing, threading and other hand operations. (Fig 1)

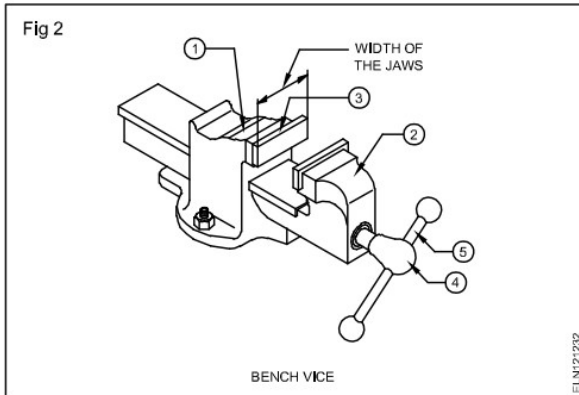
The size of the vice is stated by the width of the jaws.

Parts of a bench vice (Fig 2)

- Fixed jaw (1)
- Movable jaw (2)
- Hard jaw (3)

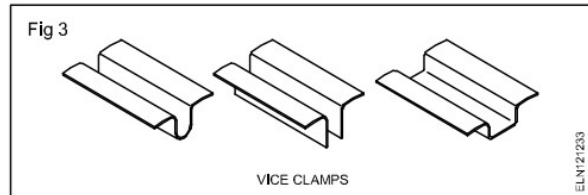


- Spindle (4)
- Handle (5)
- Box nut (6)
- Spring (7)



The box nut and the spring are the internal parts.

Vice clamps or soft jaws: To hold a finished work use soft jaws (vice clamps), (Fig 3) made of aluminium over the regular hard jaws. This will protect the work surface from damage. Do not over-tighten the vice so as to prevent damage to the spindle.

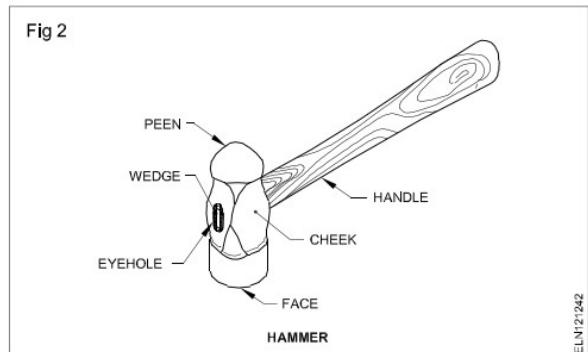
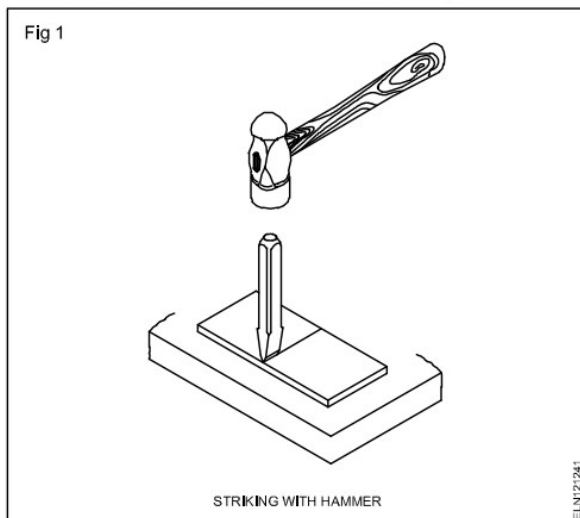


Hammer

Objectives: At the end of this lesson you shall be able to

- state the uses of an engineer's hammer
- name the parts of an engineer's hammer and state their functions
- name the types of engineer's hammers with specifications

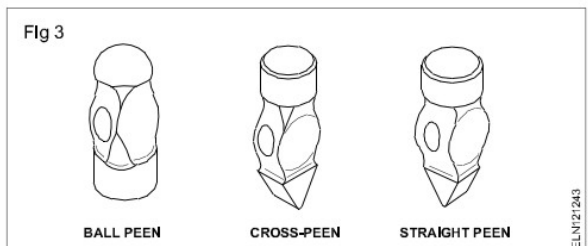
Hammer: Engineer's hammer is a hand tool used for various striking purposes like punching, bending, straightening, chipping, forging and riveting. (Fig 1)



- cheek
- eyehole

Face: Face is the striking portion. A slight convexity is given to it, to avoid digging of the edge.

Peen: Peen is the other end of the head. It is used for shaping and forming work like riveting and bending. The peen is of different shapes. (Fig 3) They are:



Major parts of a hammer (Fig 2)

- Head
- Handle

The head is made of drop-forged carbon steel, and the wooden handle must be capable of absorbing shock.

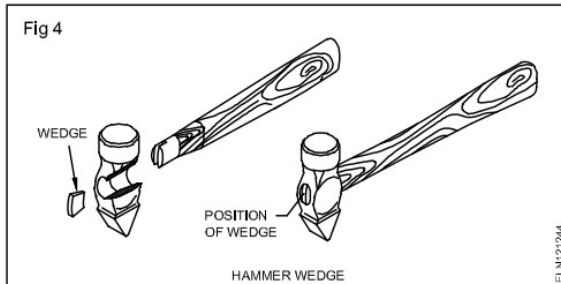
The parts of the hammer head are:

- face

- ball peen
- cross-peen
- straight peen

Cheek: Cheek is the middle portion of the hammer head. The weight of the hammer is stamped here.

Eyehole: Eyehole is meant for fixing the handle. It is shaped to fix the handle rigidly. The wedge fixes the handle in the eyehole. (Fig 4)



Specifications: The face and peen are hardened.

The cheek is left soft.

Engineer's hammers are specified by the weight of the head and shape of the peen. The weight varies from 125 gms to 1.5 kg.

The weight of the engineer's hammer used for marking purposes is 250 gms.

The ball peen hammer is used for general work in machine fitting shops.

Before using a hammer:

- make sure the handle is properly fitted
- select the correct weight of hammer suitable for the type of work
- check the head and handle for any crack
- ensure the face of the hammer is free from oil or grease.

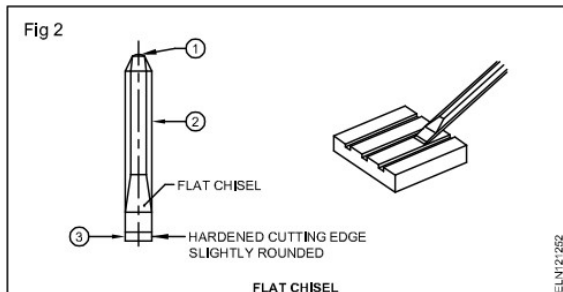
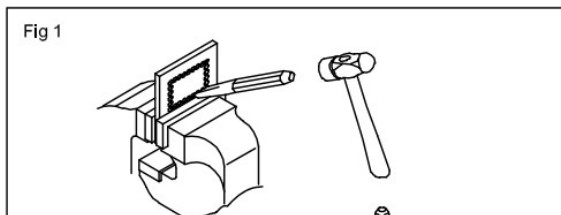
Chisel

Objectives: At the end of this lesson you shall be able to

- list the uses of a cold chisel
- name the parts of a cold chisel and its types
- state the different types of hacksaw frames, blades and their uses.

The cold chisel is a hand cutting tool used by fitters for chipping and cutting operations.

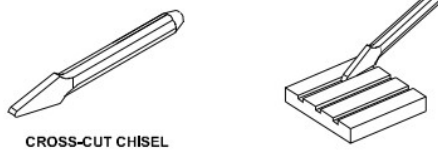
Chipping is an operation of removing excess metal with the help of a chisel and hammer. (Fig 1) The chipped surfaces being rough, they should be finished by filing.



Common types of chisels

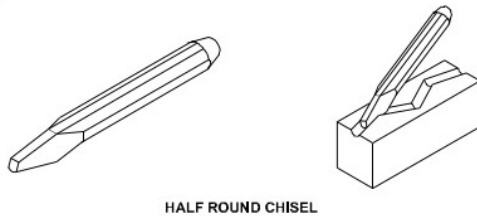
- Flat chisel

Fig 3



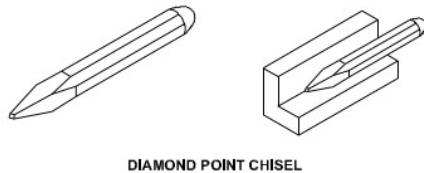
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Fig 4



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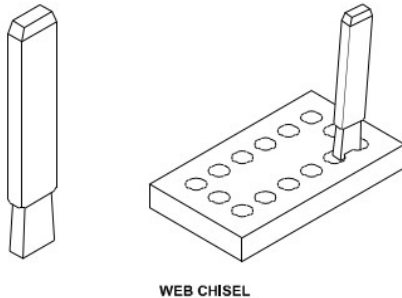
Fig 5



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eb chisels/punching chisels are used for separating
etals after chain drilling. (Fig 6)

Fig 6



ELN121256

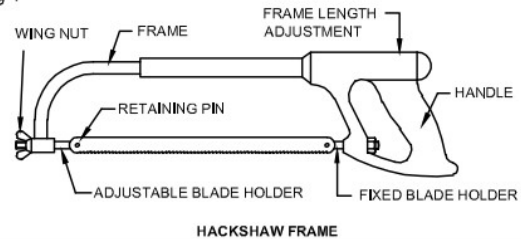
isels are specified according to the:
length
width of the cutting edge
type

..... of the

Adjustable frame tubular type (Fig 1): This is the most commonly used type. It gives a better grip and control while sawing.

Hacksaw blades : The hacksaw blade is a thin, narrow steel band with teeth and two pin holes at the ends. It is

Fig 1



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used along with a hacksaw frame. These blades are made of either low alloy steel (la) or high speed steel (hs) and are available in standard lengths of 250mm and 300mm.

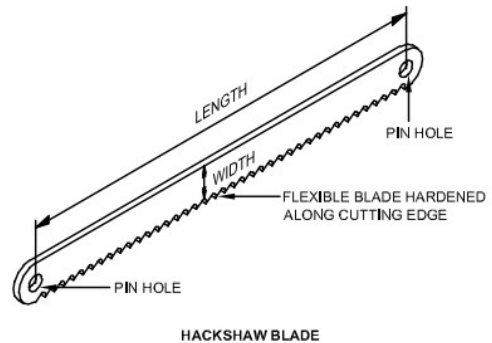
For proper working, it is necessary to have frames of rigid construction.

Types of hacksaw blades

All-hard blades: The width between the pin holes is hardened all along the length of the blade.

Flexible blades: For these types of blades only the teeth are hardened. Because of their flexibility, these blades are useful for cutting along curved lines (Fig 2).

Fig 2



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Pitch of the blade: This is the distance between two adjacent teeth. (Refer Fig 3) Hacksaw blades are designated according to length, pitch and the type of blade

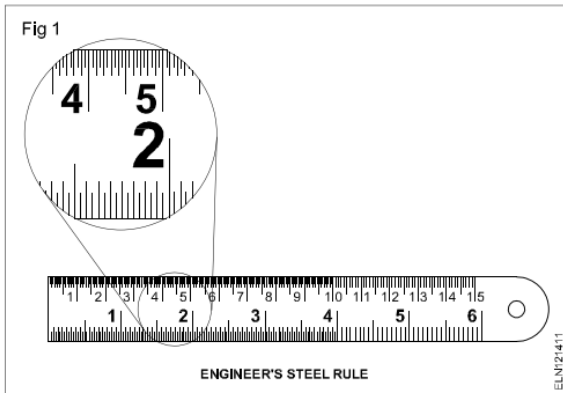
Objectives: At the end of this lesson you shall be able to

- state the constructional features of an engineer's steel rule
- explain the uses of the steel rule
- state the maintenance aspects to be considered in respect of the steel rule.

Engineer's steel rule: When dimensions are given in a drawing without any indication about the tolerance, it has to be assumed that measurements are to be made with a steel rule.

Material and sizes of steel rules: Steel rules are made of spring steel or stainless steel. The edges are accurately ground to form a straight line.

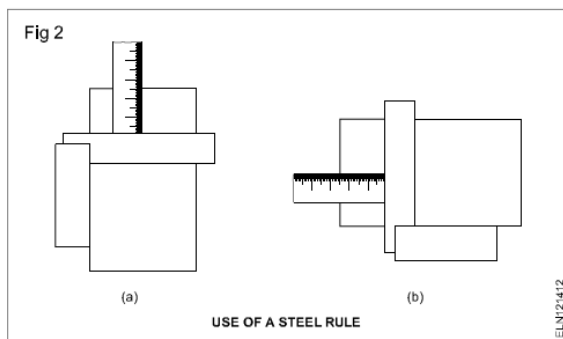
Steel rules are available in different lengths; the common sizes are 150mm, 300mm and 600mm. (Refer Fig 1)



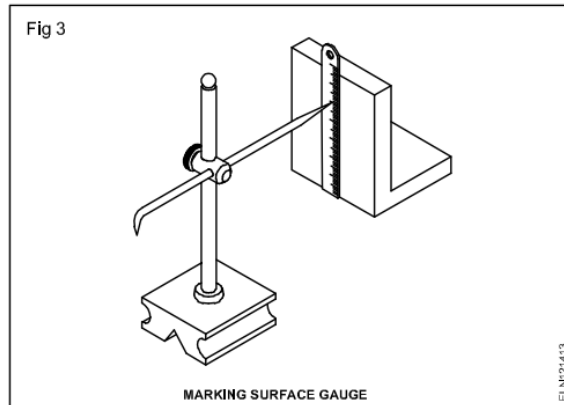
The surfaces of the steel rules are satin-chrome finished to reduce glare and also to prevent rusting. The engineer's rule is graduated in 10mm, 5mm, 1mm and 0.5mm. Thus the reading accuracy of a steel rule is 0.5mm.

Graduation: The minimum graduation is 0.5mm.

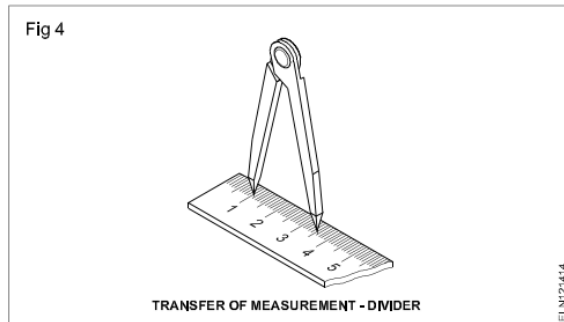
Uses: Use a try square on one datum edge and measure the distance from the other datum edge using a steel rule. (Figs 2a & b)



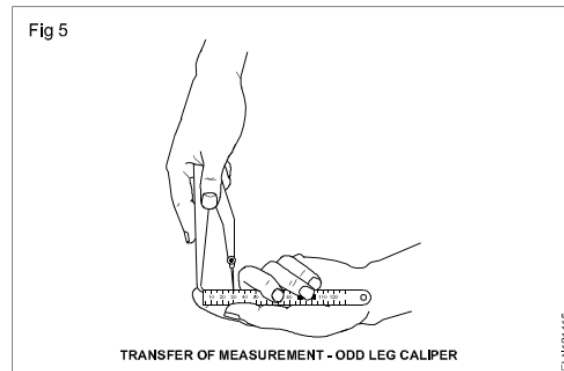
A steel rule is used to take the desired height for the marking surface gauge. (Fig 3)



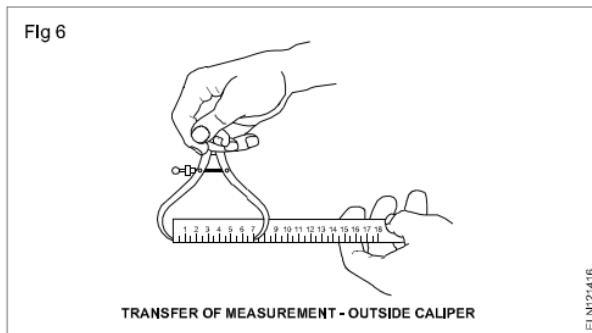
Transfer of measurement from the steel rule to the divider is shown in Fig 4.



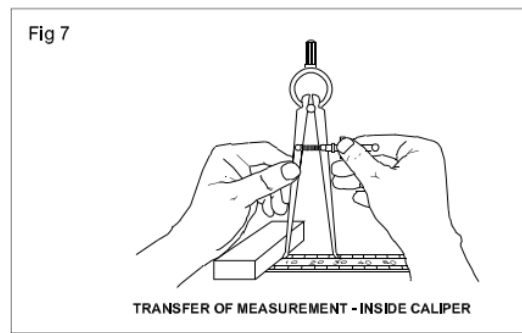
Steel rule is used to transfer measurements from the rule to the odd leg calipers. (Fig 5)



Steel rule is used to transfer measurements from the steel rule to outside calipers. (Fig 6)



A steel rule is also used to transfer measurements to inside calipers. (Fig 7)



Marking media

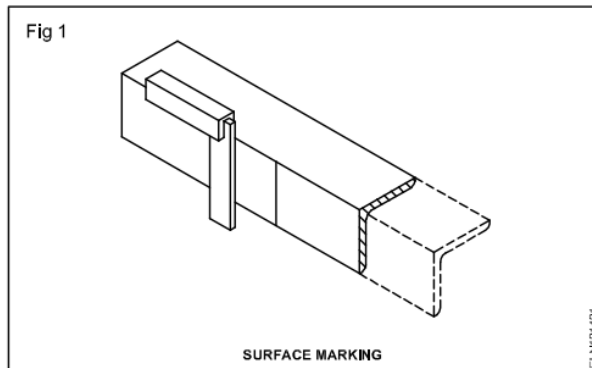
Objectives: At the end of this lesson you shall be able to

- name the common types of marking media
- select the correct marking media for different applications.

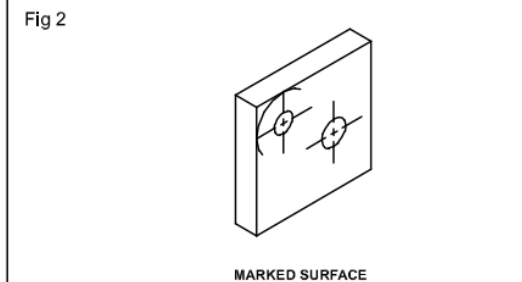
Different types of marking media

Whitewash: This is applied to rough forgings and castings with oxidised surfaces. (Fig 1) Whitewash is prepared in many ways.

- Chalk powder mixed with water
- Chalk mixed with methylated spirit
- White lead powder mixed with turpentine



Prussian blue: Used on filed or machine-finished surfaces. This will give very clear lines but takes more time for drying than the other marking media. (Fig 2)



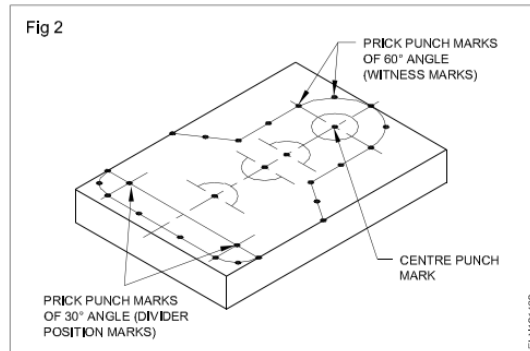
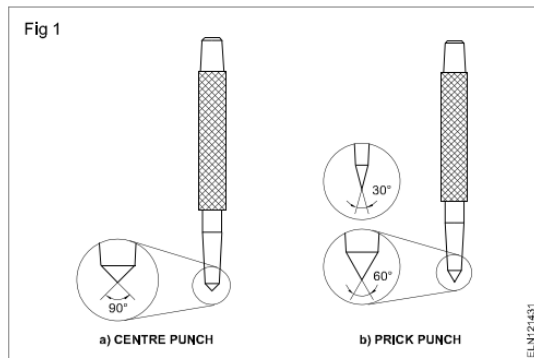
Copper sulphate: Used on filed or machine-finished surfaces. Copper sulphate sticks to the finished surface well. The solution is prepared by mixing copper sulphate with a few drops of nitric acid added.

Copper sulphate needs to be handled carefully as it is poisonous. Copper sulphate coating should be dried before commencing marking as otherwise it may stick on the instruments used for marking.

Cellulose lacquer: This is a commercially available marking medium. It is made in different colours and dries very quickly.

The selection of marking media depends on the:

- the surface finish



Types of calipers

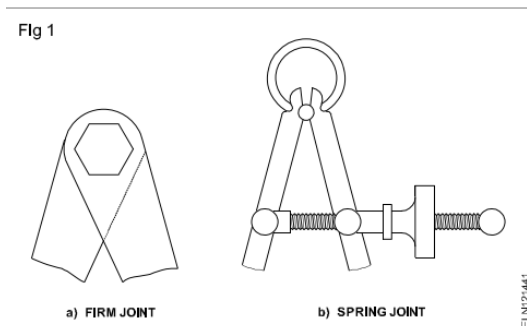
Objectives: At the end of this lesson you shall be able to

- name the commonly used calipers
- compare the features of firm joint and spring joint calipers
- state the advantages of spring joint calipers.

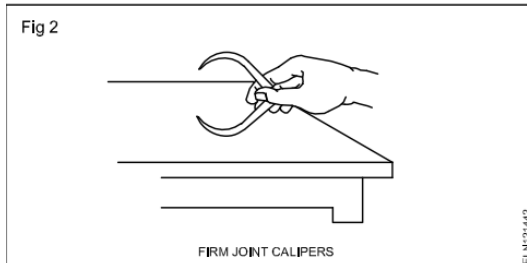
Calipers (firm and spring joints) : Calipers are simple measuring instruments used to transfer measurements from the steel rule to objects and vice versa.

The commonly used calipers are:

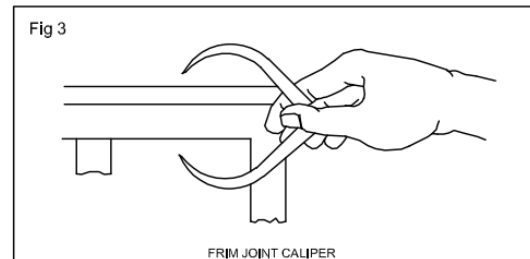
- firm joint calipers (Fig 1a)
- spring joint calipers. (Fig 1b)



Firm joint calipers : In the case of firm joint calipers both legs are pivoted on one end. To take measurement of the workpiece, it is opened roughly to the size. Fine setting is done by lightly tapping it on a wooden surface. (Figs 2 & 3)



Spring joint calipers: For these type of calipers, the legs are assembled by means of a pivot loaded with a spring. For opening and closing of the caliper legs a screw and nut are provided.

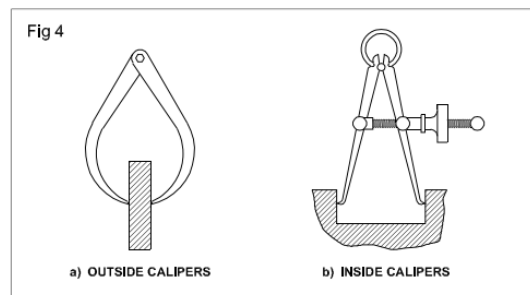


Spring calipers have the advantage of quick setting. The setting made will not change unless the nut is turned. Caliper sizes are specified by the length which is the distance between the pivot centre and the tip of the leg.

Accuracy of the measurement taken depends very much on the sense of 'FEEL' or 'TOUCH' while measuring the job. You should get the feel when the legs are just touching the surface.

Outside and inside measurements: Calipers used for outside measurements are known as outside calipers while calipers used for internal measurements are the inside calipers. (Figs 4a & 4b)

Calipers are used with steel rules whose accuracy is limited to 0.5 mm; parallelism can be checked with a higher degree of accuracy.



Jenny calipers

Objectives: At the end of this lesson you shall be able to

- state the constructional features of jenny calipers
- name the types of jenny calipers
- state the uses of jenny calipers.

Jenny calipers: Jenny calipers are used for marking and layout work.

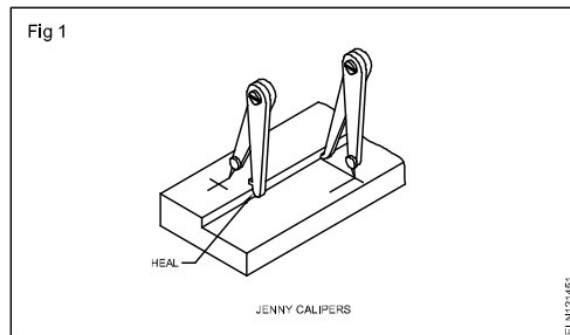
These calipers are also known as

- hermaphrodite calipers
- odd leg calipers
- leg and joint calipers

Jenny calipers have one leg with an adjustable divider point while the other is a bent leg. The legs are joined together to make a firm joint.

Uses

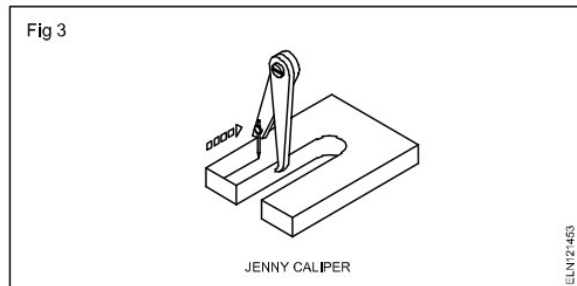
- To mark lines parallel to edges inside and outside. (Fig 1)



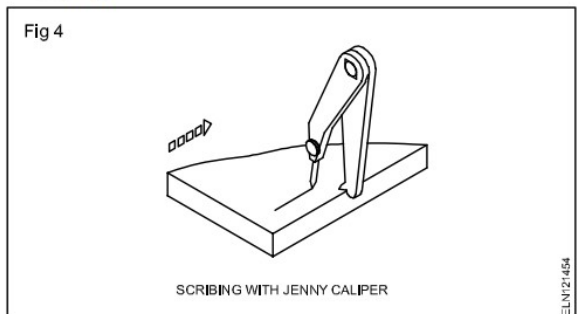
- To locate the centre of round bars. (Fig 2)



Jenny calipers can also be used for scribing lines along curved edges. While setting dimensions and scribing lines, both legs should be of equal length. (Fig 3)



The jenny caliper should be slightly inclined while scribing lines, Fig 4.



While setting dimensions for accurate setting, the jenny caliper's point should 'click' into the graduation, Fig 5.



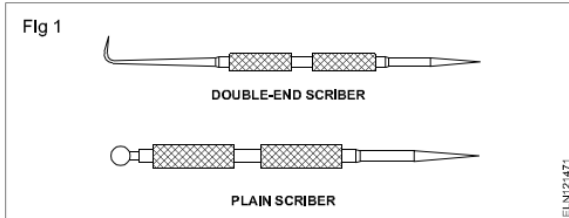
Scriber, divider

Objectives: At the end of this lesson you shall be able to

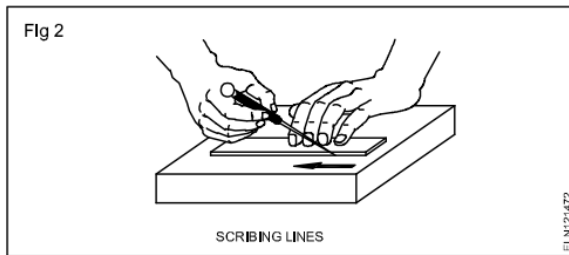
- state the features of scribers and dividers
- state the uses of scribers and dividers.

Scriber: A scriber is a sharp, pointed, steel tool made from carbon tool steel. There are two types of scribers.

- Double end and plain scribers (Fig 1)



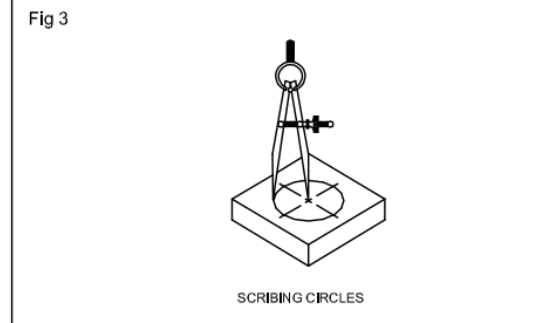
Uses: Used for scribing lines on the metal being laid out. (Fig 2)



Divider: A divider consists of a pair of steel legs adjusted by a screw and nut, and held together by a circular spring at one end. A handle is inserted on the spring.

Uses: A divider is used for

- measuring distances between points
- transferring measurements directly from a rule
- scribing circles and arcs on metals. (Fig 3)



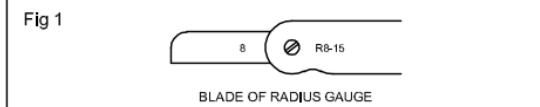
Radius gauges

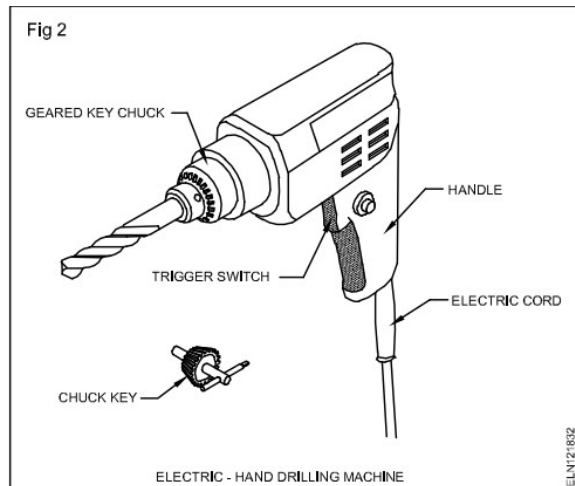
Objectives: At the end of this lesson you shall be able to

- state the uses of radius gauges
- state the features of radius gauges.

Radius gauges: Radius gauges are used to check the internal and external radius of workpieces.

These gauges are made of high quality steel sheets and are finished to accurate radius.





Precautions to be observed : Make sure the holes are properly located and punched with a centre punch.

Check the drill size. If the markings on the drill are not clear, use a drill gauge.

Be sure the drill is properly centred in the chuck by turning (rotating).

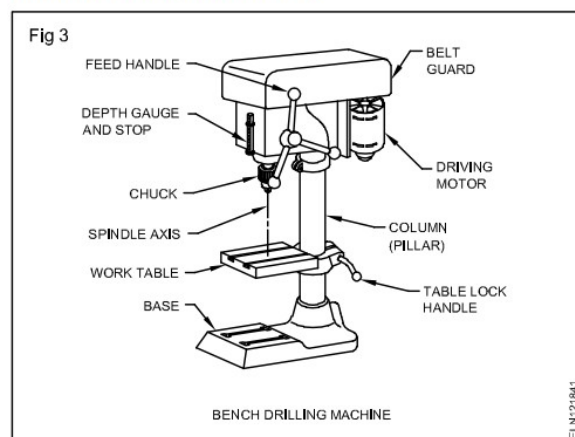
Be sure the work is mounted properly in a holding device such as a vice or 'G' clamp.

Check the centering of the drill after the point has just started in the metal. Relocate the hole with a centre punch, if necessary. Feed the drill with a light, even pressure.

Types of Electric Drilling Machines: Some of the electric drilling machines are listed here.

- The sensitive bench drilling machine
- The pillar drilling machine
- The radial arm drilling machine. (Radial drilling machine)

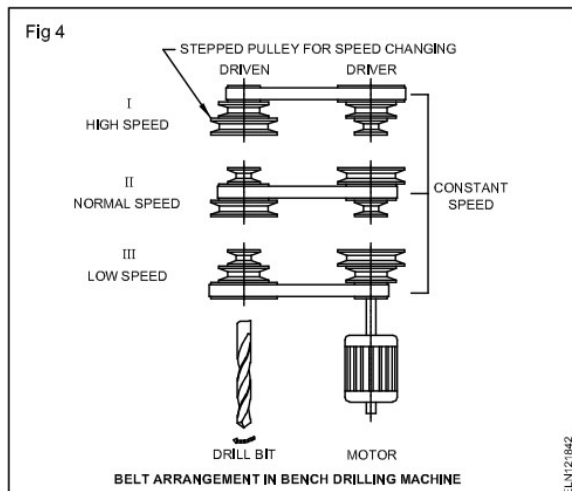
(As you are not likely to use the column and radial type of drilling machines now, only the sensitive and pillar type machines are explained here.)



with its various parts marked. This machine is used for light duty work. (Fig 3)

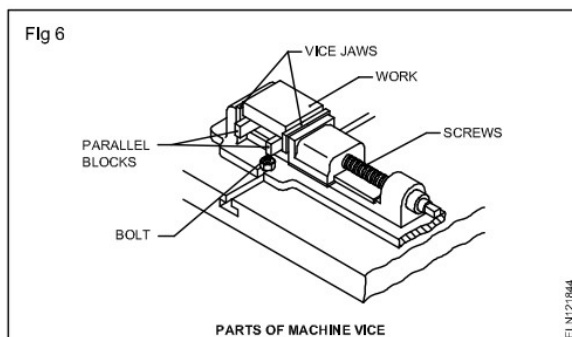
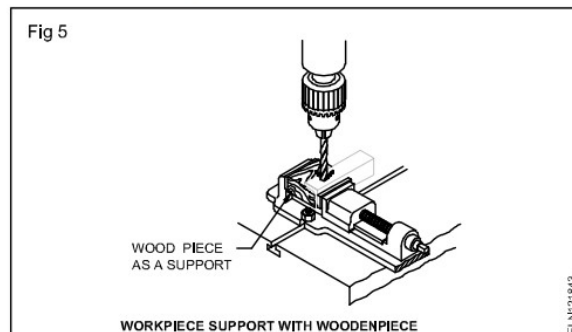
This machine is capable of drilling holes up to 12.5mm diameter. The drills are fitted in the chuck or directly in the tapered hole of the machine spindle.

Different spindle speeds are achieved by changing the belt position in the stepped pulley (Fig 4).



For normal drilling, the work surface is kept horizontal. If the holes are to be drilled at an angle, the table can be tilted.

The pillar drilling machine: This is an enlarged version of the sensitive bench drilling machine. These drilling machines are mounted on the floor and are driven by more powerful electric motors. They are used for heavy duty work. Pillar drilling machines are available in different



Electrician - Wires - Joints - Soldering - UG cables**Fundamental of electricity - conductors - insulators - wire size measurement - crimping**

Objectives: At the end of this lesson you shall be able to

- define electricity and atom
- explain about the atomic structure
- define the fundamental terms and definition of electricity
- state the type of supply, polarity and the effects of electric current
- state the conductors, insulators, wires - size measurement methods

Introduction

Electricity is one of the today's most useful sources of energy. Electricity is of utmost necessity in the modern world of sophisticated equipment and machinery.

Electricity in motion is called electric current. Whereas the electricity that does not move is called static electricity.

Examples of static electricity

- Shock received from door knobs of a carpeted room.
- Attraction of tiny paper bits to the comb.

Structure of matter

Electricity is related to some of the most basic building blocks of matter that are atoms (electrons and protons). All matter is made of these electrical building blocks, and, therefore, all matter is said to be 'electrical'.

Atom

Matter is defined as anything that has mass and occupies space. A matter is made of tiny, invisible particles called molecules. A molecule is the smallest particle of a substance that has the properties of the substance. Each molecule can be divided into simpler parts by chemical means. The simplest parts of a molecule are called atoms.

Basically, an atom contains three types of sub-atomic particles that are of relevance to electricity. They are the electrons, protons and neutrons. The protons and neutrons are located in the centre, or nucleus, of the atom, and the electrons travel around the nucleus in orbits.

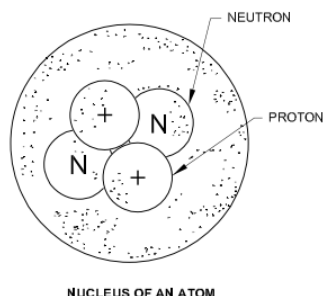
Atomic structure**The Nucleus**

The nucleus is the central part of the atom. It contains the protons and neutrons in equal numbers shown in Fig 1.

Protons

The proton has a positive electrical charge. (Fig 1) It is almost 1840 times heavier than the electron and it is the permanent part of the nucleus; protons do not take an active part in the flow or transfer of electrical energy.

Fig 1

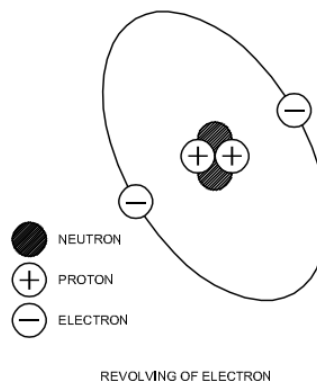


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Electron

It is a small particle revolving round the nucleus of an atom (as shown in Fig 2). It has a negative electric charge. The electron is three times larger in diameter than the proton. In an atom the number of protons is equal to the number of electrons.

Fig 2



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Neutron

A neutron is actually a particle by itself, and is electrically neutral. Since neutrons are electrically neutral, they are not too important to the electrical nature of atoms.

Energy shells

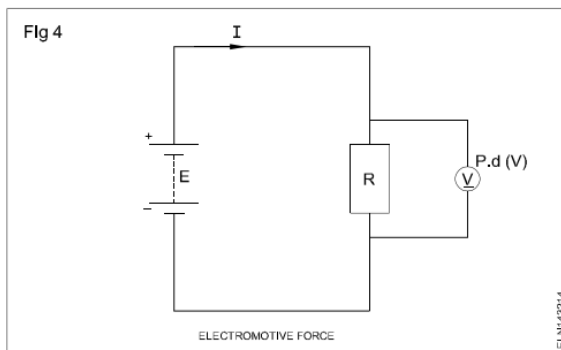
In an atom, electrons are arranged in shells around the nucleus. A shell is an orbiting layer or energy level of one or more electrons. The major shell layers are identified by numbers or by letters starting with 'K' nearest the nucleus

Electro Motive Force (EMF)

In order to move the electrons in a circuit- that is to make the current to flow, a source of electrical energy is required. In a torch light, the battery is the source of electrical energy.

The terminals of the battery are indicated in the circuit symbol by two lines, the longer line for the positive and the shorter for the negative terminal.

Within the battery the negative terminal contains an excess of electrons whereas the positive terminal has a deficit of electrons. The battery is said to have an electromotive force (emf) which is available to drive the free electrons in the closed path of the electrical circuit. The difference in the distribution of electrons between the two terminals of the battery produces this emf.



In Simple,

Electromotive force (EMF) is the electrical force, which is initially available in electrical source, cause to move the free electrons in a conductor

Its unit is 'Volt'

It is denoted by letter 'E'

It cannot be measured by any meter. It can be only calculated by using the formula

$$E = \text{Potential Difference (P.D)} + \text{V. drop}$$

$$= \text{p.d} + \text{V.drop}$$

$$E = V + IR$$

Electromotive force is essential to drive the electrons in circuit

This force is obtained from the source of supply i.e. Torch lights, dynamo

System International (SI) unit of electromotive force is Volts (symbol 'E')

Potential Difference (PD)

The difference of voltage and pressure across two points in a circuit is called a potential difference (p.d) and is measured in volts.

In a circuit, when a current flows, there will be a potential difference across the terminals of the resistor/load. In the

circuit shown in Fig 4, when the switch is open, the voltage across the terminals of the battery is the electromotive force (E) whereas when the switch is in the closed position, the voltage across the terminals is the potential difference (p.d) which will be less than the electromotive force earlier measured. This is due to the fact that the internal resistance of the battery causes a voltage drop when the cell supplies current to the load.

The force which causes current to flow in a circuit is called emf. Its symbol is E and its unit is Volt. It can be calculated as

$$\text{EMF} = \text{voltage at the terminal of source} + \text{voltage drop in the source of supply}$$

$$\text{or emf} = V_T + IR$$

Terminal voltage (p.d)

It is the voltage available at the terminals of the source. Its symbol is V_T . Its unit is also Volt. It is measured by a voltmeter. It is given by the voltage drop in the source of supply, i.e.

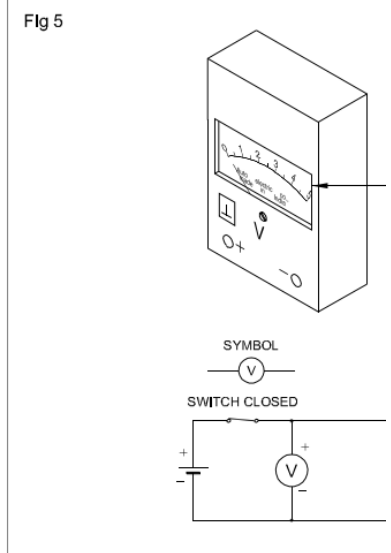
$$V_T = \text{EMF} - IR$$

where I is the current and R is the resistance of the load.

Hence EMF is always greater than p.d.

Voltmeter

Electrical voltage is measured with a voltmeter. To measure the voltage of a source, the voltmeter must be connected in parallel across the source. Positive terminal to the positive terminal and negative terminal to the negative terminal, as shown in Fig 5. The connection is across or it is a parallel connection.



For the decimal or decimal sub-multiple of the following expressions.

$$\begin{aligned} 1 \text{ kilo-volt} &= 1 \text{ KV} = 1000 \text{ V} \\ &= 1 \times 10^3 \text{ V} \end{aligned}$$

The unit of electrical resistance (abbreviated as R) is ohm (symbol Ω).

For the decimal multiples or decimal sub-multiples of the ohm we use the following expressions:

1 megohm	= 1 M Ω = 1000000 Ω	= $1 \times 10^6 \Omega$
1 kilo-ohm	= 1 k Ω = 1000 Ω	= $1 \times 10^3 \Omega$
1 milli-ohm	= 1 m Ω = 1/1000 Ω	= $1 \times 10^{-3} \Omega$
1 micro-ohm	= 1 $\mu\Omega$ = 1/1000000 Ω	= $1 \times 10^{-6} \Omega$

Meter to measure resistance

Ohmic value of a medium resistance is measured by an ohmmeter or a Wheatstone bridge. (Fig 6) There is a provision to measure the ohmic value of a resistance in a multimeter. There are various methods to determine the ohmic value of resistance. Some of these methods will be explained later in this book.

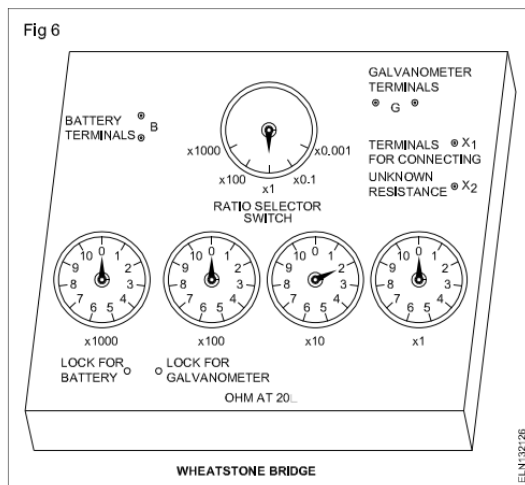


Fig 6

conductance is the reciprocal of resistance. Its symbol is G ($G = 1/R$) and its unit is mho represented by Ω^{-1} . Good conductors have large conductances and insulators have small conductances. Thus if a wire has a resistance of R Ω , its conductance will be $1/R$.

Quantity of electricity

As the current is measured in terms of the rate of flow of electricity, another unit is necessary to denote the quantity of electricity (Q) passing through any part of the circuit in a certain time. This unit is called the coulomb (C). It is denoted by the letter Q. Thus

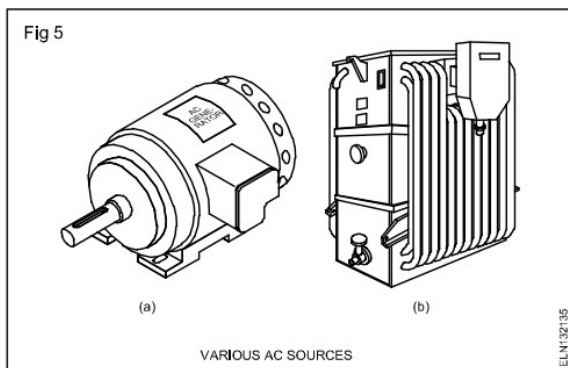
$$\text{Quantity of electricity} = \text{current in amperes (I)} \times \text{time in seconds (t)}$$

$$\text{or } Q = I \times t$$

Coulomb

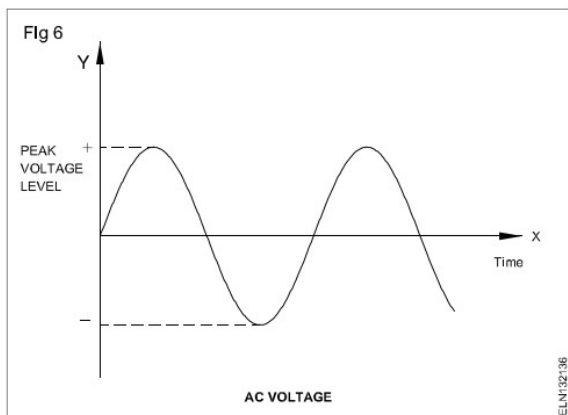
It is the quantity of electricity transferred by a current of one ampere in one second. Another name for the above unit is the ampere-second. A larger unit of the quantity of electricity is the ampere-hour (A.h) and is obtained when the time unit is in hours

$$1 \text{ A.h} = 3600 \text{ Asec or } 3600 \text{ C}$$



Alternating voltage

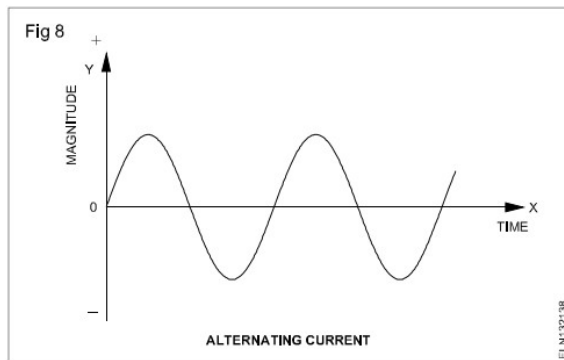
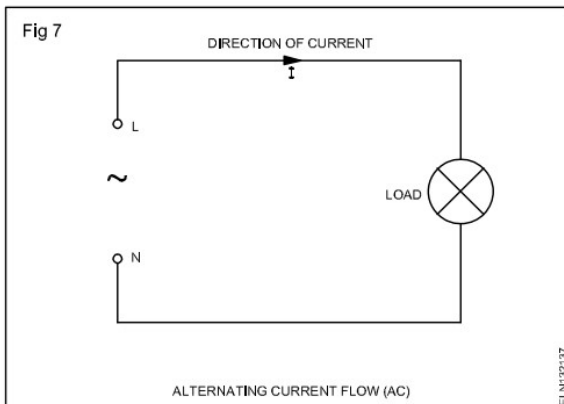
AC supply sources change their polarity constantly, and consequently the direction of voltage also magnitude. The voltage supplied to our homes by power plants is alternating. Fig 6 shows a sinusoidal alternating voltage over time (wave-form).



AC supply is expressed by the effective value of the voltage, and the number of times it changes in one second is known as frequency. Frequency is represented by 'F' and its unit is in Hertz(Hz).

For example, the AC supply used for lighting is 240V 50 Hz. (Alternating voltage in common use is known as AC voltage.) AC supply terminals are marked as phase/line(L) and neutral(N).

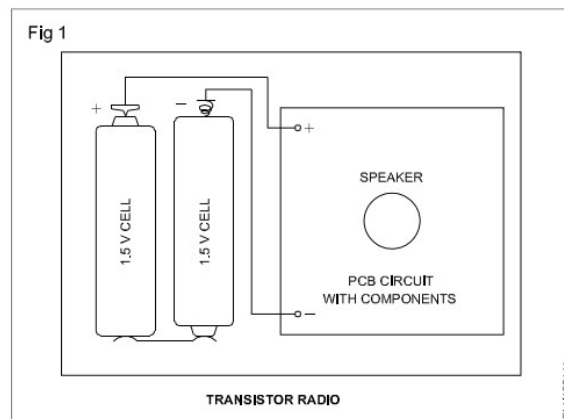
Current is caused in an electric circuit due to the application of voltage. If an alternating voltage is applied to an electrical circuit, an alternating current (commonly known as AC current) will flow. (Figs 7 and 8)



Polarity test in DC

Polarity

The polarity of a DC supply source should be identified as positive or negative. We can also use the term to indicate how an electric device is to be connected to the supply. For example, when putting new cells in a transistor radio we must put the cells correctly such that the positive terminal of one cell connects to the positive terminal of the radio and the negative terminal of the other cell connects to the negative terminal of the radio as shown in Fig 1.

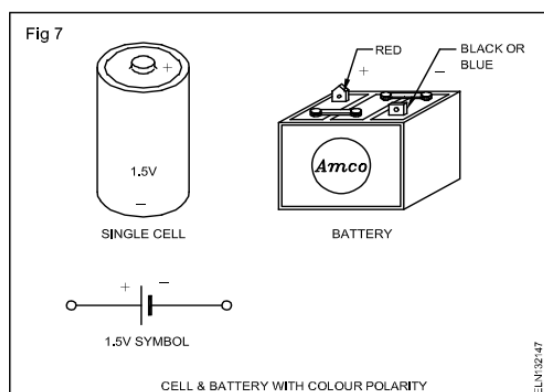


In the same way to find out the polarity of DC generator or a DC source it is advisable to use a moving coil type voltmeter with a suitable range, of say 0-300 volts (Fig 6). To protect the meters, always use higher range meters above the rated voltage of the generator or DC source supply.

Marking made in practice

Generally in DC source the +ve terminal of the supply lead is Red in colour and -ve terminal of the supply lead is Blue or Black in colour. Battery terminals are marked as +ve and -ve on the body or on the terminal post.

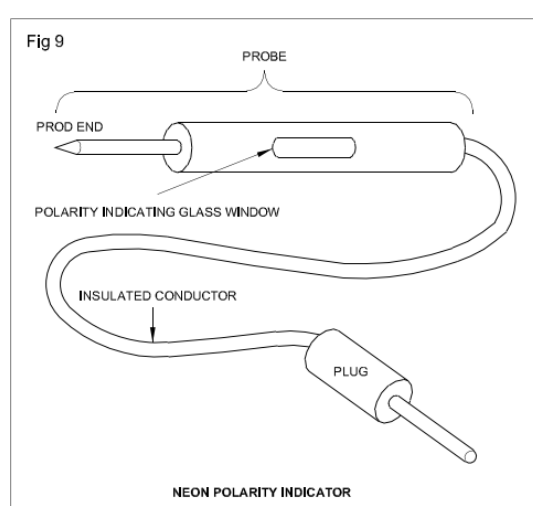
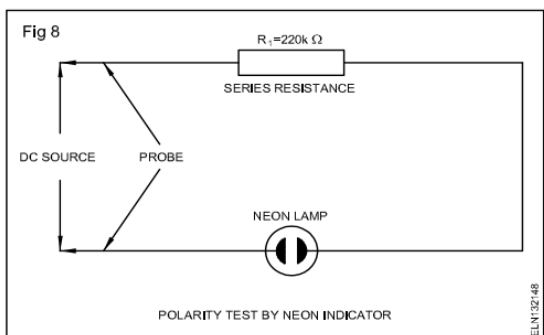
- For cells on top of the cell is marked as +ve and the bottom is marked as -ve
- The battery terminal is marked as + and is Red in colour, and the other terminal is marked as - and Black or Blue in colour. (Fig 7)



Neon polarity indicator

To check the polarity, a neon lamp in series with a 220k ohms resistor could be used (as shown in Fig 8). Touch the probes of the neon lamp circuit across the circuit to be tested. The lamp will light when voltage is present. If both electrodes in the lamp glow, you have an AC power source. If only one electrode glows, the voltage is DC and the lighted electrode will be on the side of the negative polarity of the source.

Therefore, you also have a polarity check on DC circuits. (Fig 8) A commercial neon polarity indicator is shown in Fig 9. It has an indicating glass window in which the polarity touched by the pointed end of the indicator will be displayed as +ve or -ve through neon signs.



Effects of electric current

When an electric current flows through a circuit, is judged by its effects, which are given below.

1 Chemical effect

When an electric current is passed through a conducting liquid (i.e. acidulated water) called an electrolyte, it is decomposed into its constituents due to chemical action. The practical application of this effect is utilized in electroplating, block making, battery charging, meta refinery, etc.

2 Heating effect

When an electric potential is applied to a conductor, the flow of electrons is opposed by the resistance of the conductor and thus some heat is produced. The heat produced may be greater or lesser according to the circumstances, but some heat is always produced. The application of this effect is in the use of electric presses heaters, electric lamps, etc.

3 Magnetic effect

When a magnetic compass is placed under a current carrying wire, it is deflected. It shows that there is some relation between the current and magnetism. The wire carrying current does not become magnet but produces a magnetic field in the space. If this wire is wound on an iron core (i.e. bar), it becomes an electro-magnet. This effect of electric current is applied in electric bills, motors, fans electric instruments, etc.

4 Gas ionization effect

When electrons pass through a certain gas sealed in a glass tube, it becomes ionised and starts emitting light rays, such as in fluorescent tubes, mercury vapour lamps sodium vapour lamps, neon lamps, etc.

5 Special rays effect

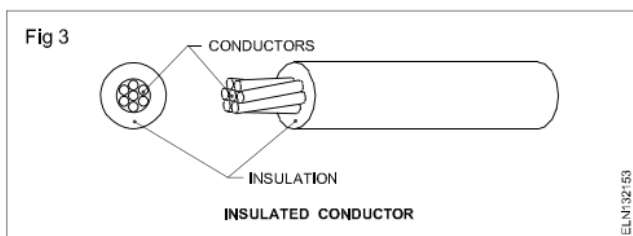
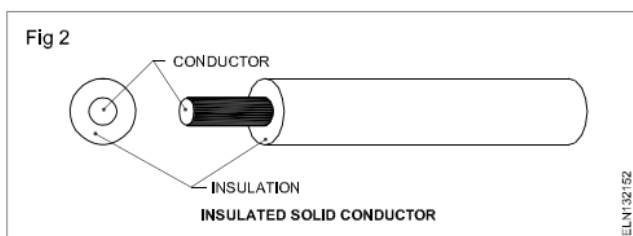
Special rays like X-rays and laser rays can also be developed by means of an electric current.

without danger. Additional covering over the insulation adds mechanical strength and protection against weather, moisture and abrasion.

Solid and stranded conductors

A solid conductor is one in which there will be only one conductor in the core as shown in Fig 2. A stranded conductor is one in which there will be a number of smaller sized conductors twisted to form the core as shown in Fig 3.

The number of conductors ranges from 3 to 162 and the conductor size varies from 0.193 mm to 3.75 mm diameter depending upon the current carrying capacity and also upon whether these conductors are used in cables or overhead lines.



Normally stranded conductors are designated as 10 sq. mm cable of size 7/1.40 where 10 sq. mm gives the area of the cross-section, in the size, numerator (7) gives the number of conductors and the denominator 1.40 gives the diameter of the conductor in mm. Alternatively 7/1.40 cable is the same as 7/17 whereas in the latter case the denominator is expressed in Standard Wire Gauge (SWG) number.

Stranded conductors are more flexible and have better mechanical strength. According to recent stipulation, the cable size should be expressed in sq. millimetres or they can be expressed in terms of the number of conductors in the cable and the diameter of the conductor in mm.

Cable

A cable is a length of single, insulated conductor (single or stranded), or two or more such conductors - each provided with its own insulation, and are laid up together. The insulated conductor or conductors may or may not be provided with an overall mechanical protective covering.

Cable (armoured)

An armoured cable is provided with a wrapping of metal (usually in the form of tape or wire) serving as a mechanical

Core

All cables have one central core or a number of stranded conductors forming high conductivity. There are one, two, three, three and half and four. Each core is insulated separately and then insulation is applied around the cores.

Wire

A solid substance (conductor) or an insulated (solid or stranded) subjected to tensile stress without screen is called a wire.

Copper and aluminium

In electrical work, mostly copper and aluminium are used for conductors. Though silver is a better conductor than copper, it is not used for general work due to its high cost.

Copper used in electrical work is made with a degree of purity, say 99.9 percent.

Characteristics of copper

- 1 It has the best conductivity next to silver.
- 2 It has the largest current density per unit area compared to other metals. Hence the volume required for a given current is less for a given length.
- 3 It can be drawn into thin wires and sheets.
- 4 It has a high resistance to atmospheric corrosion; hence, it can serve for a long time.
- 5 It can be joined without any special provision for electrolytic action.
- 6 It is durable and has a high scrap value.

Next to copper, aluminium is the metal used for conductors.

Characteristics of aluminium

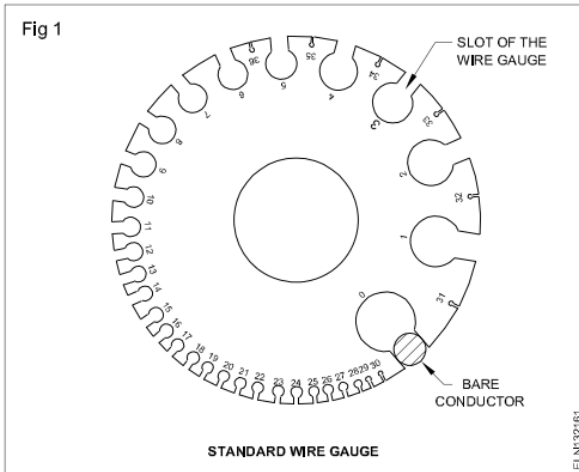
- 1 It has good conductivity, next to copper. When compared to copper, it has 60.6 percent conductivity. For the same current capacity, the cross-section of an aluminium wire should be larger than that of a copper wire.
- 2 It is lighter in weight.
- 3 It can be drawn into thin wires and sheets. Its tensile strength on reduction of the cross-sectional area.
- 4 A lot of precautions need to be followed when using aluminium conductors.
- 5 The melting point of aluminium is low, hence it is damaged at points of loose connection where heat is developed.
- 6 It is cheaper than copper.

To measure the size of conductors, a electrician can use normally a standard wire gauge or an outside micrometer for more accurate results.

The size of wires are designed more carefully by the manufacturers. Though the Bureau of Indian Standards (BSI) specifies the cables by the area of the cross-section in square millimetres, the manufacturers still produce the cable with the diameter of each wire and number of wires in the stranded cables. Sometimes the indicated size of cable by the manufacturer may not be correct and the electrician has to ascertain the size by measurement.

Standard Wire Gauge (SWG)

The size of the conductor is given by the standard wire gauge number. According to the standards each number has an assigned diameter in inch or mm. This is given in Table 1. The standard wire gauge, shown in Figure 1 could measure the wire size in SWG numbers from 0 to 36. It should be noted that the higher the number of wire gauge the smaller is the diameter of the wire.

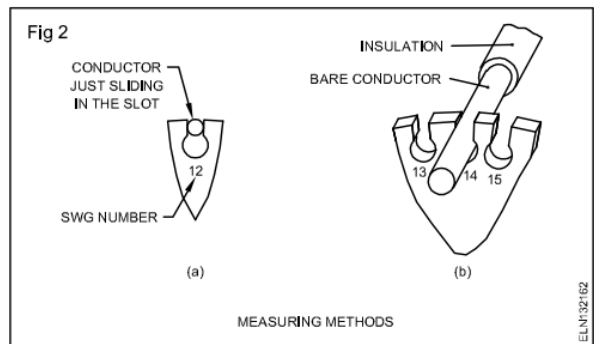


For example, SWG No. 0 (zero) is equal to 0.324 inch or 8.23 mm in diameter whereas SWG No.36 is equal to 0.0076 inch or 0.19 mm in diameter.

While measuring the wire, the wire should be cleaned and then inserted into the slot of the wire gauge to determine the SWG number (Fig 2). The slot in which the wire just slides in is the correct slot and the SWG number could be read in the gauge directly. In most of the wire gauges to save the trouble of referring to the table, the wire diameter is inscribed on the reverse of the gauge.

American Wire Gauge (AWG)

The American wire gauge is different from the British standard wire gauge. In an American wire gauge (AWG) the diameter is represented in mils rather than inch or mm. One mil is one thousandth part of an inch. Please note there is no direct conversion from AWG to SWG.



Measurement of wire size by Outside micrometers

A micrometer is a precision instrument used to measure a job, generally within an accuracy of 0.01 mm.

Micrometers used to take the outside measurements are known as outside micrometers. (Fig 1)

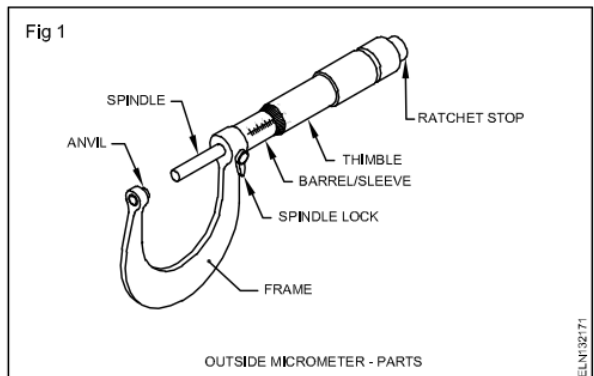
The parts of a micrometer

Frame

The frame is made of drop-forged steel or malleable cast iron. All other parts of the micrometer are attached to this.

Barrel/sleeve

The barrel or sleeve is fixed to the frame. The datum line and graduations are marked on this.



Objectives: At the end of this lesson you shall be able to:

- state the necessity of proper termination
- list the different types of terminations
- describe the parts and their functions of crimping tool
- state the advantages of crimping termination

Necessity of termination

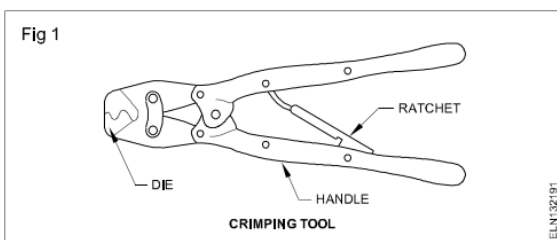
Cables are terminated at electrical appliances, accessories and equipment etc. for providing electrical connections. All terminations must be made to provide good electrical continuity, and made in such a manner as to prevent contact with other metallic parts and other cables.

Loose terminations will lead to overheating of cables, plugs and other connecting points due to higher resistance at those terminations. Fires may also be started due to the excess heat. Wrong termination like excess or extended conductor touching metallic part of the equipment may lead to giving shock to the person who comes in contact with the equipment.

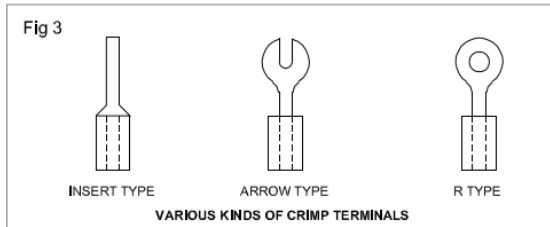
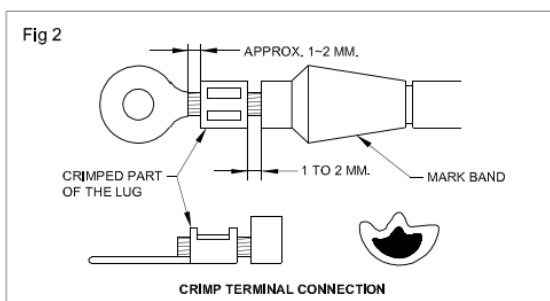
Touching of strands projecting from one terminal with other terminal leads to short circuit. To conclude, we can state that wrong termination will lead to overheating of terminating points and cables, short circuits and earth leakage.

Types of termination

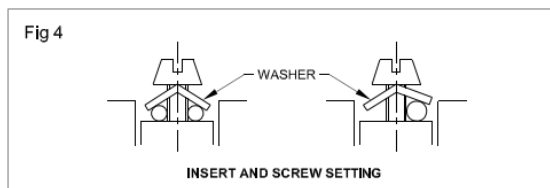
Crimp connection: In this type of connection the conductor is inserted into a crimp terminal and is then crimped with a crimping tool (Fig 1).



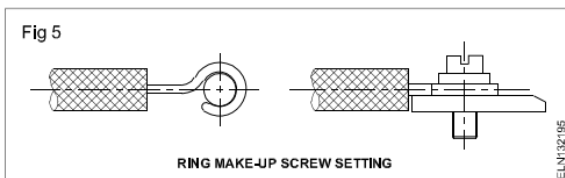
It is important to choose a crimp terminal that matches the conductor diameter and the dimensions of the connecting screw terminal. (Figs 2 and 3)



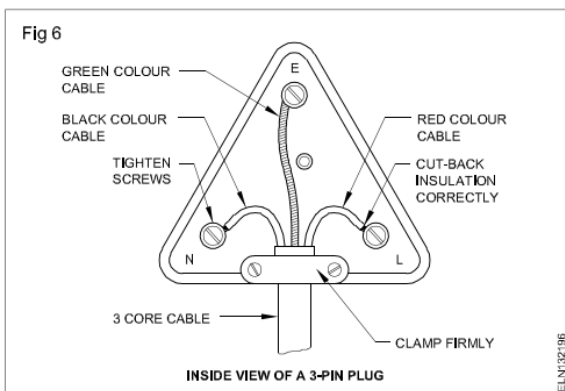
Insert screw setting: The conductor is inserted between the terminal block and the special form of washer (Fig 4), and then the screw is tightened.



Screw on terminals with loop/ring conductor: A loop is formed clockwise in the bare portion of the conductor to match the size of the screw diameter. Then the loop is inserted to the screw and tightened. (Fig 5) In the case of a stranded conductor, soldering of the loop is essential to prevent strands getting fray.



While connecting the plug and socket for extension of the cable, Line (L), the Neutral (N) and Earth (E) terminals must be properly identified by markings on them. (Fig 6)



The colour code while connecting 3 core cable must be properly followed. Red wire to L, black/blue to N, green wire or yellow with green line to E terminal. The earth terminal in a 3 pin plug is bigger than the other two.

Crimping and crimping tool

The ends of cables can be prepared for termination with lugs by the soldering process or by mechanical means - compression or crimp fitting.

In crimp compression fitting, a ring-tongued terminal (lug) is to be compressed to the bared end of an insulated multi-strand cable. The process is called crimping and the tool used is called crimping pliers or crimping tool.

Compression type connectors apply and maintain pressure by compressing the connector around the conductor.

The principal purpose of the pressure is to establish and maintain suitable low contact resistance between the contact surfaces of the conductor. Improper crimping will create increased contact resistance and will cause overheating while carrying electrical load.

Crimping tools

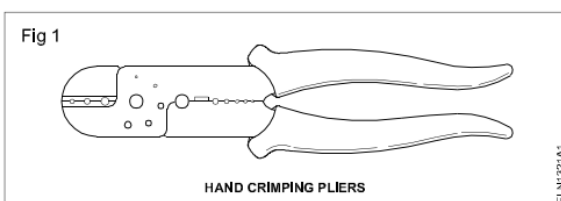
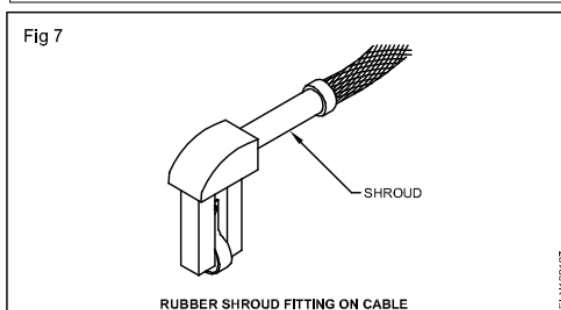
The crimping pliers illustrated in Fig 1 is of a type which crimps from 0.5 to 6 mm cables.

Connections and terminals

There is an electrical fire risk if:

- the current-carrying capacity of the cable is inadequate
- the capacity of the plug is inadequate
- the insulation is cut back too far
- the conductor is damaged while cutting back the insulation
- the connections are not right
- the cable is not adequately supported at the point of entry to the plug or to the appliance.

When a reinforcing rubber shroud is provided, ensure that it is used. (Fig 7)



The tool is operated by squeezing the handles. The jaws move together, grip and then crimp the fitting. Using the crimping tool that matches the specific crimp lug will give the correct crimping force for a properly executed crimp. Properly executed crimp will indent the top of the lug and the indentation will hold the conductor securely as shown in Fig 2.

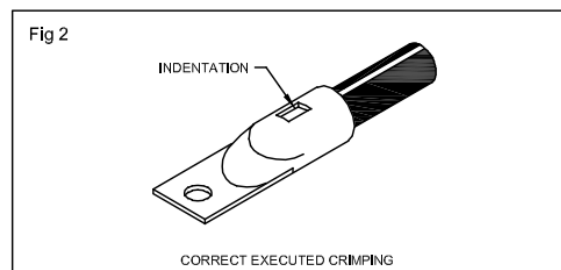
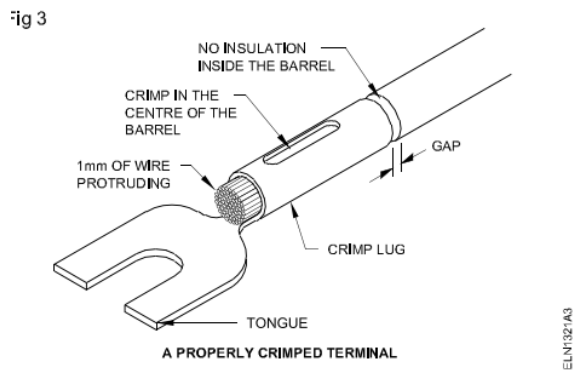


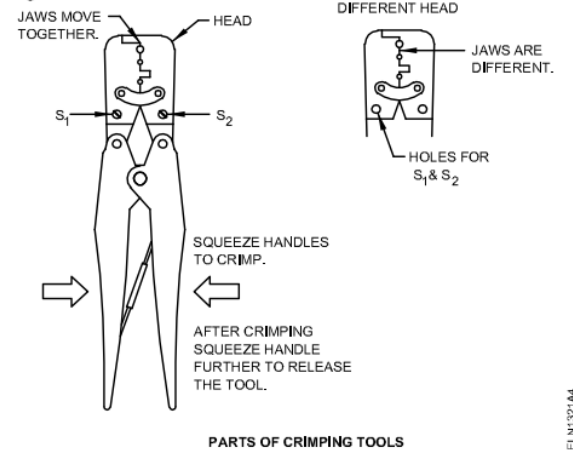
Fig 3



Terminal lug crimping pliers are available in lengths ranging from 180 to 300 mm. Crimping tools are available in sets. For higher capacity cables crimping tools are operated by hydraulic force.

Fig 4 shows another type of crimping tool which crimps from 26 to 10 SWG.

Fig 4



The head and jaws, may be removed, by unscrewing the screws S_1 and S_2 . A head with different shaped jaws may then be secured to the tool. The shape of the jaws determines the shape of the crimp (indent). Some crimp actions are shown in Fig 5.

Safety

When using this type of crimping tool care must be taken not to trap the finger, as the operating cycle of the tool is non-reversible i.e. once the handles are squeezed together the jaws can only be released by applying further pressure to the handles as shown in Fig 4.



Terminal types

It is important to consider both the mechanical and electrical requirements when selecting a lug connector.

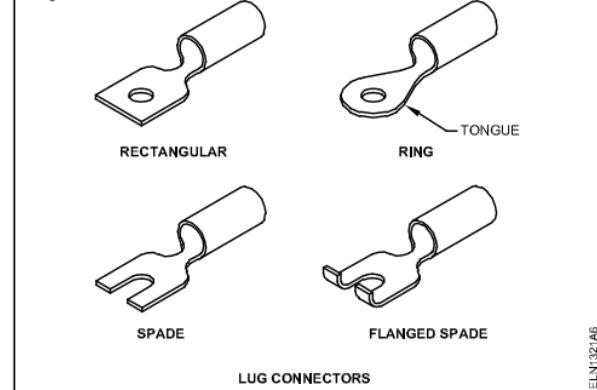
The factors are:

- the type of tongue, i.e. rectangular, ring, spade, etc.
- the mechanical size, i.e. tongue size and thickness, hole size etc. for the cable selected
- the electrical considerations such as the current carrying capacity, that may also determine some of the mechanical dimensions.

The electrical and mechanical requirements for the lug and the base material of the lug are decided by the cable material, and the place of connection will determine the minimum tongue size and the barrel size. The most commonly used base materials are copper and brass. Nickel, aluminium and steel are also used, but less frequently.

Fig 6 shows some lug connectors normally used in practice terminals. They are ring, rectangular, spade, flanged spade etc. Ring and rectangular terminals are not intended for frequent removal to disconnect the terminal whereas in spade and flanged spade lugs (terminals) the screw need not be removed to disconnect.

Fig 6



Precautions for crimping tool application

Do not handle the job/tool roughly e.g. drop, hammer, etc. which may harm the tool.

Do not alter the crimping tool, e.g. alter the shape of the die etc.

Objective: At the end of this lesson you shall be able to

- state the different types of wire joints and their uses
- state the necessity of soldering and types of soldering
- state the purpose and types of fluxes
- explain the different method of soldering and techniques of soldering
- explain the type of solder and flux used for soldering aluminium conductor

Joints in electrical conductors are necessary to extend the cables, overhead lines, and also to tap the electricity to other branch loads wherever required.

Definition of joint: A joint in an electrical conductor means connecting/tying or interlaying together of two or more conductors such that the union/junction becomes secured both electrically and mechanically.

Types of joints: In electrical work, different types of joints are used, based on the requirement. The service to be performed by a joint determines the type to be used.

Some joints may require to have good electrical conductivity. They need not necessarily be mechanically strong.

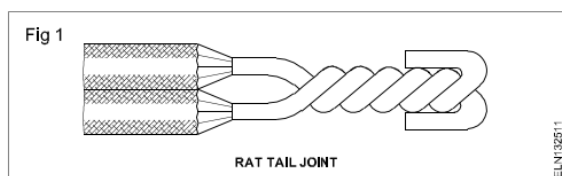
Example : The joints made in junction boxes and conduit accessories.

On the other hand, the joints made in overhead conductors, need to be not only electrically conductive but also mechanically strong to withstand the tensile stress due to the weight of the suspended conductor and wind pressure.

Some of the commonly used joints are listed below.

- Pig-tail or rat-tail
- twisted joints
- Married joint
- Tee joint
- Britannia straight joint
- Britannia tee joint
- Western union joint
- Scarfed joint
- Tap joint in single stranded conductor

Pig-tail/Rat-tail/Twisted joint: (Fig 1) This joint is suitable for pieces where there is no mechanical stress on the conductors, as found in the junction box or conduit accessories box. However, the joint should maintain good electrical conductivity.

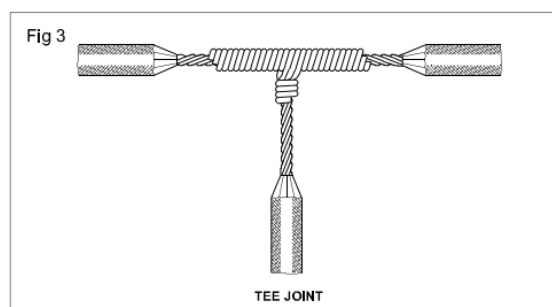


Married joint: (Fig 2) A married joint is used in places where appreciable electrical conductivity is required, along with compactness.

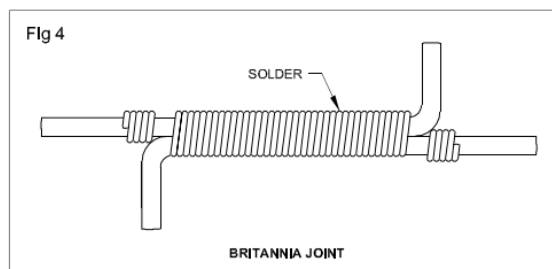


As the mechanical strength is less, this joint could be used at places where the tensile stress is not too great.

Tee joint (Fig 3): This joint could be used in overhead distribution lines where the electrical energy is to be tapped for service connections.

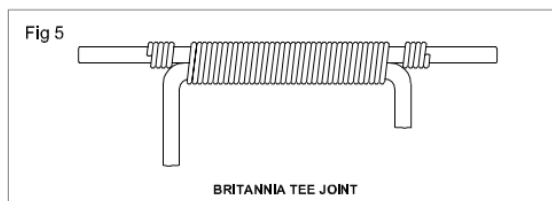


Britannia joint: (Fig 4) This joint is used in overhead lines where considerable tensile strength is required.

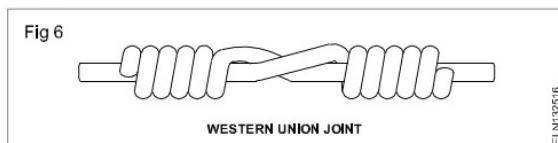


It is also used both for inside and outside wiring where single conductors of diameter 4 mm or more are used.

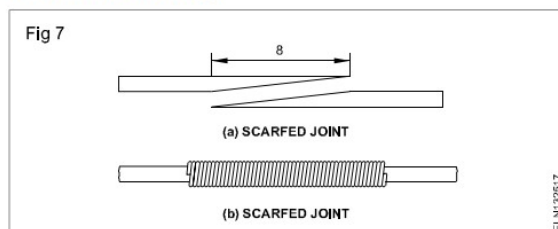
Britannia tee joint: This joint (shown in Fig 5) is used for overhead lines for tapping the electrical energy perpendicular to the service lines.



lines for extending the length of wire where the joint is subjected to considerable tensile stress.



Scarfed joint (Fig 7): This joint is used in large single conductors where good appearance and compactness are the main considerations, and where the joint is not subjected to appreciable tensile stress as in earth conductors used in indoor wiring.



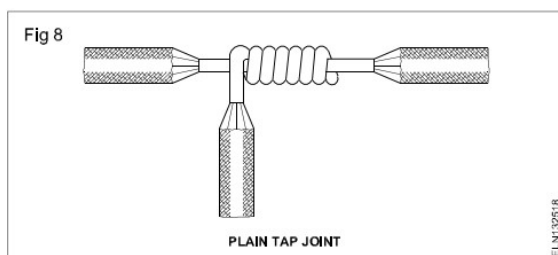
Tap joints in single stranded conductors of diameter 2 mm or less

By definition, a tap is the connection of the end of one wire to some point along the run of another wire.

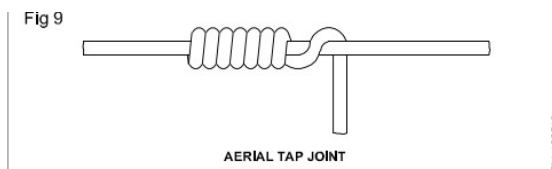
The following types of taps are commonly used.

- Plain
- Aerial
- Knotted
- Cross - Double - Duplex

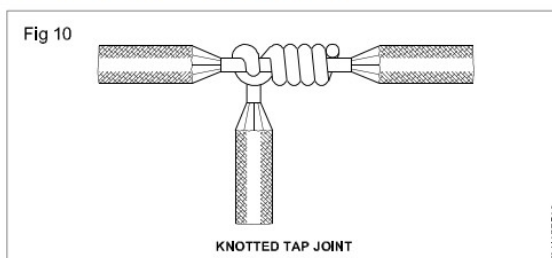
Plain tap joint: (Fig 8) This joint is the most frequently used, and is quickly made. Soldering makes the joint more reliable.



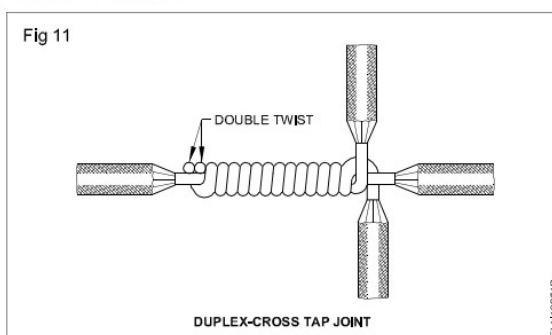
Aerial tap joint : (Fig 9) This joint is intended for wires subjected to considerable movement, and it is left without soldering for this purpose. This joint is suitable for low current circuits only. It is similar to the plain tap joint except that it has a long or easy twist to permit the movement of the tap wire over the main wire.



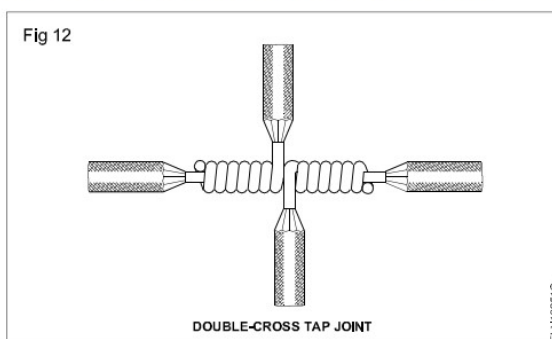
Knotted tap joint : (Fig 10) A knotted tap joint is designed to take considerable tensile stress.



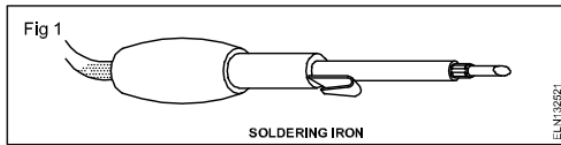
Duplex cross-tap joint: (Fig 11) This joint is used where two wires are to be tapped at the same time. This joint could be made quickly.



Double-cross tap joint: (Fig 12) This joint (shown in Fig 12) is simply a combination of two plain taps.



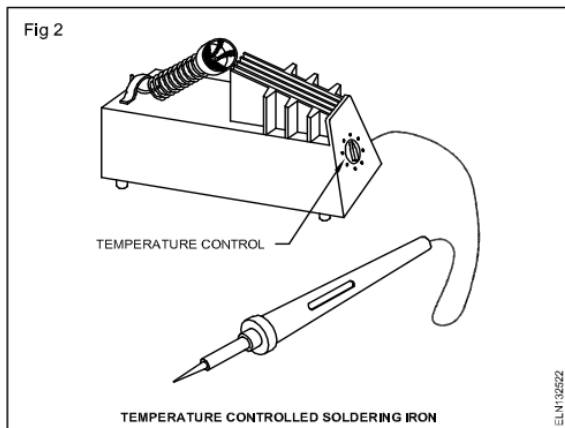
method of soldering is with a soldering iron as shown in Fig 1. This is widely used for most kinds of soft soldering work.



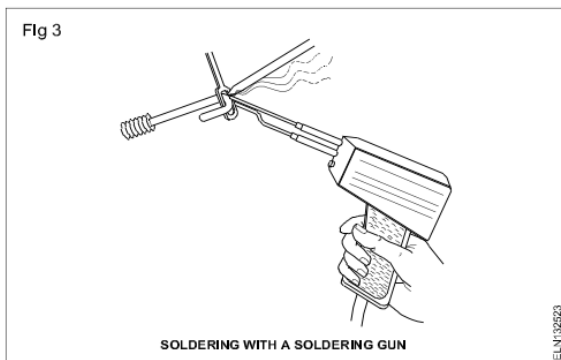
This tool is simple and inexpensive. Soldering irons are available in a wide range of sizes and models. Heating is generally by electrical means, though non-electrical irons are also used.

Temperature controlled soldering

For soldering miniature components on printed circuit boards, a temperature-controlled soldering iron is used as shown in Fig 2. The electrical supply given to the soldering iron is of low voltage, and is completely isolated from the main supply. Low voltage does not endanger the life of the user and will also not spoil the sensitive electronic components. Controlled temperature makes the job easy for the user.



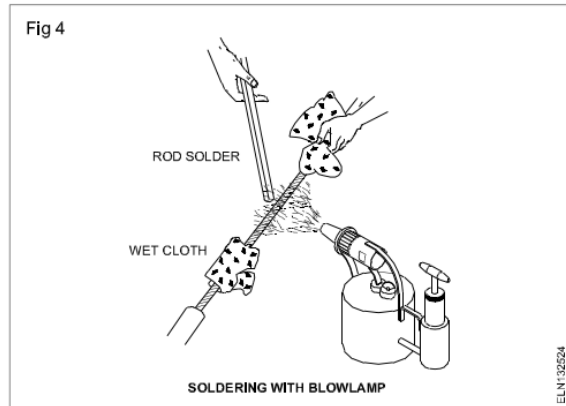
Soldering with a soldering gun: This method, shown in Fig 3, is used for individual soldering, e.g. for servicing and repair work.



When the heat capacity of a soldering iron is inadequate.

This method, shown in Fig 4, permits rapid heating and is used primarily for larger jobs, such as piping and cable work, vehicle body repairs and some applications in the building trade.

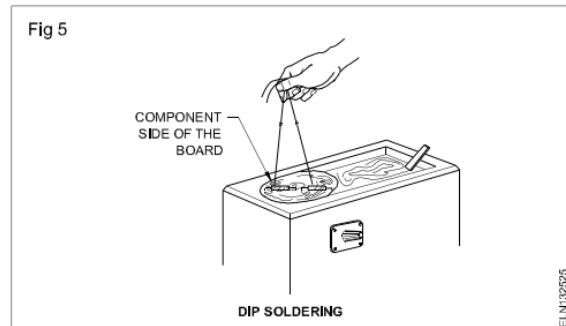
This method requires skilful management of the flame.



Dip soldering: This method, shown in Fig 5, is used for quantity production and for tinning work similar to component soldering on Printed Circuit Boards (P.C.B.). Components to be soldered or tinned are dipped into a bath of molten solder, which is heated electrically.

The solder is kept in motion by an agitator in order to obtain an even temperature and to keep the surface free from oxides. If no agitator is provided, the surface must be protected or skimmed at regular intervals to remove the oxides.

The temperature can be controlled very accurately.



Machine soldering: This method, shown in Fig 6, is used for quantity production, and is based on the principle that molten solder or a mixture of oil and molten solder is set in rapid motion, thus breaking up the oxide film. The solder comes into direct contact with the component ends to be soldered.

Soldering machines of different designs are used for wave soldering, cascade soldering and jet soldering.

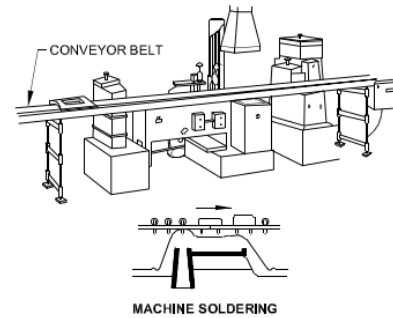
Equipment for machine soldering is expensive and the cost of production is high.

Accurate temperature control can be arranged.

Apart from these, any one of the following methods can also be used for soldering.

- Resistance soldering
- Induction soldering
- Ovensoldering
- Soldering in vegetable oil
- Soldering by hot gas

Fig 6



ELN132526

Soldering - Techniques - pot and laddle

Soldering with electric soldering iron: In this method, the joining surface is first cleaned and then the flux is applied over the surface. The joint is then heated, and the solder is kept over the surface to be soldered, and heat is applied by keeping the soldering iron tip over it. The solder melts and spreads on the surface evenly.

The electric soldering iron: The heating element in the iron is heated by an electric current passing through it.

The bit is heated by the heating element.

The face of the bit is the part of the iron, used to make contact with the surfaces to be soldered.

Soldering irons of the following voltages and input power (wattage) are available (I.S.950-1980).

Ratings

Voltage	6	12	24	50	110	230 or 240
Wattage	25	25	25	25	25,75, 250	5,10,25,75, 125,250,500

Select an iron with adequate power to suit the size of the work.

The bit: Most bits are made of copper because it is a good conductor of heat. The face of the bit may be either:

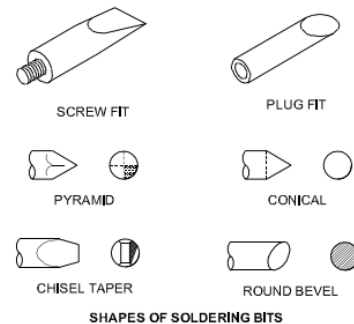
- un-plated or
- iron-plated.

Iron-plated faces do not wear out as rapidly as un-plated faces.

Most irons are so constructed that the bit can be changed.

Different shapes of bits are available as shown in Fig 1.

Fig 1

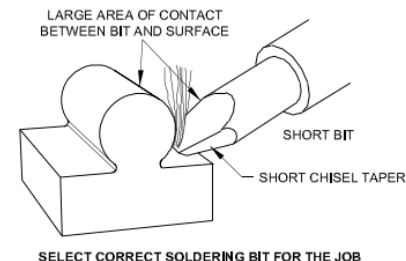


ELN132531

Selecting the bit (Fig 2): Select the bit to give a compromise between:

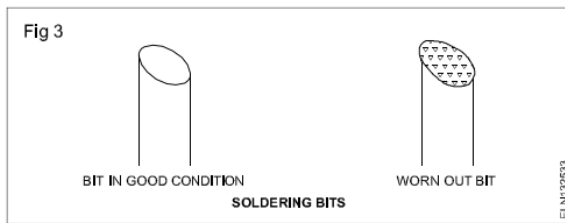
- the best approach to the work
- the shortest bit and bit taper
- the ideal contact with the surfaces.

Fig 2



ELN132532

quickly and get covered in oxide. If the iron is in constant use, this will occur within a few hours.

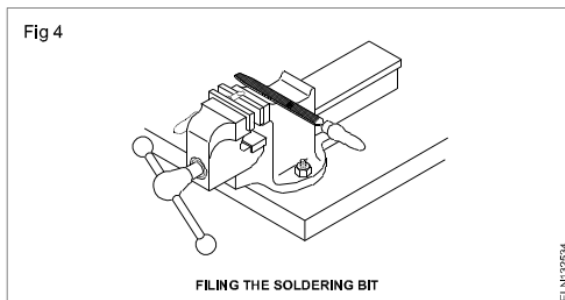


To make a good soldered joint, the bit must be maintained clean, smooth and correctly shaped.

Dressing the bit (Fig 4): To dress an un-plated bit follow the procedure stated below.

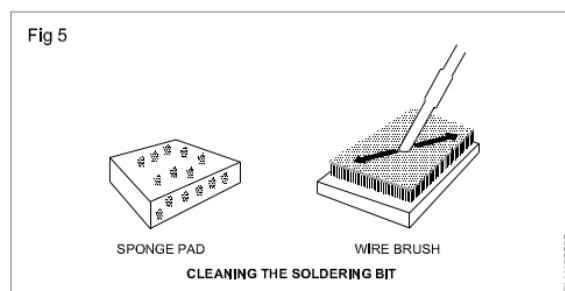
- Switch off, unplug the iron and allow it to cool.
- Remove the bit from the iron, if possible.
- Mount the bit in a vice.
- File to shape.

Do not file the bit in an electronic assembly area. Copper dust from the bit may settle in the equipment and cause a short circuit. Iron-plated bits must not be filed. Renew when worn out.



Cleaning the bit: (Fig 5) The bit should be cleaned frequently. To clean the bit, rub the face of the un-plated bits on a wire brush or special sponge pad when the iron is hot.

Iron-plated bits must not be cleaned on a wire brush. Rub on a sponge pad.



Wetting (soldering): To make a good joint, the solder must flow evenly over and between the surfaces to be soldered. Wetting is a term used to describe the extent to which this occurs.

- the surfaces are clean
- sufficient flux of the correct type is used
- the surfaces are hot enough
- the surfaces have been tinned.

Techniques of soldering

Soldering involves the following main operations.

- Tinning the soldering iron
- Cleaning the parts to be soldered
- Applying the solder

Tinning the soldering iron: To make the solder adhere to the tip of the soldering iron, the surface of the tip must be coated with the solder, and this operation is known as tinning.

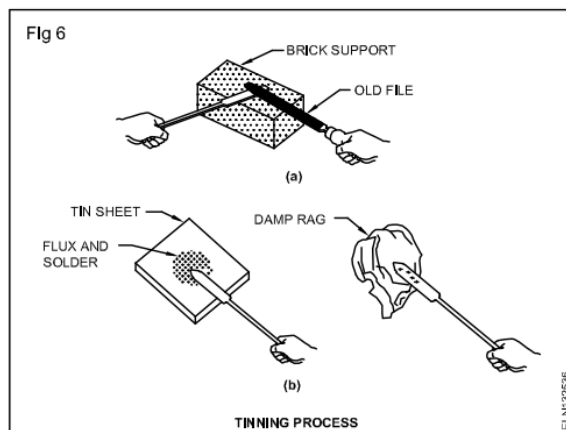
First the tip is cleaned with a cloth and heated either directly or indirectly. The tip is then filed to remove the scales, and is wiped again with a cloth.

The right temperature for tinning could be judged by the change of colour of the tip when heated. If the surface of the copper tip tarnishes immediately, the temperature is high and needs to be cooled slightly by withdrawing the source of heat temporarily. A correctly heated tip tarnishes slowly.

After the soldering iron tip attains the correct temperature, place a small quantity of solder and the flux on a tin plate and rub the bit on the mixture. The solder should stick to the surface of the tip evenly. Wipe out the superfluous solder with a clean damp cloth.

The whole process of tinning is shown in Figures 6a and 6b.

The surface should present a bright silvery appearance when properly tinned.



Cleaning the surface to be soldered: The parts to be soldered should be well cleaned for perfect soldering. The scales, dirt, oil and grease should be completely removed either by wiping or by rubbing with a sandpaper. Immediately after cleaning, the flux should be applied on the surface to avoid oxidation.

Laying direct in ground:

This method involves digging a trench in the ground and laying cable(s) on a bedding of minimum 75 mm riddled soil or sand at the bottom of the trench, and covering it with additional riddled soil or sand of minimum 75 mm and protecting it by means of tiles, bricks or slabs.

Depth: The desired minimum depth from ground surface to the top of cable is as follows:

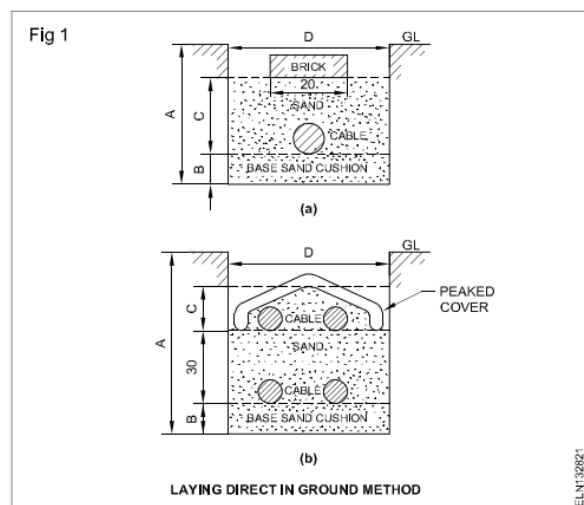
- High voltage cables, 3.3 KV to 11 KV rating : 0.9 m.
- High voltage cables, 22 KV, 33 KV rating : 1.05 m.
- Low and medium voltage and control cables : 0.75 m.
- Cables at road crossings : 1.00 m.
- Cables at railway level crossings (measured from bottom of sleepers to the top of pipe) : 1.00 m.

Width: The width of a trench for laying a single cable should be minimum 35 cm. When more than one cable is laid in the same trench in horizontal formation, the width of the trench shall be so increased that the inter-axial spacing between two cables is 20 cm.

Clearance from the terminal cable to the sides of a trench should be 15 cm.

Cable is protected by sand or layer of brick as shown in Fig 1a. Bricks should be second class bricks of a size not less than 20 cm x 10 cm x 10 cm and laid for full length for one cable (bricks to be laid breadthwise).

When more than one cable is to be laid in the same trench, this protective covering shall extend at least 5 cm. over the sides of the end cables. An alternative to this covering can be earth ware or R.C.C. or fire-bricks of peaked covers section as shown in Fig 1b.



It is good practice to leave about 3 metres of cable spare in a loop formation near poles and joints, so that in case joint fails, this additional cable comes to rescue. Cable should be laid 0.4 metre away from water and power mains.

For cable of rating

Ref.	Upto 1.1 kV	Exceeding 1.1 kV
A	75	120
A1	$(75+n1 \times 30)$	$(120+n1 \times 30)$
B	8	8
C	17	17
D	35	35
D1	$(30+n2 \times 20)$	$(30+n2 \times 20)$
E	15	15

n1 = Number of additional cables in vertical formation

n2 = Number of additional cables in horizontal formation

For road crossings cast iron, or 2nd class RCC pipe M.S/G.I. Pipe of medium class having an appropriate diameter should be laid during construction of the road to avoid damage to the road later on. The top surface of the pipe should be at a minimum depth of 1m. Pipes provided for entry to a building shall slope upward to prevent rain water into the building. After laying of the cable they shall be sealed.

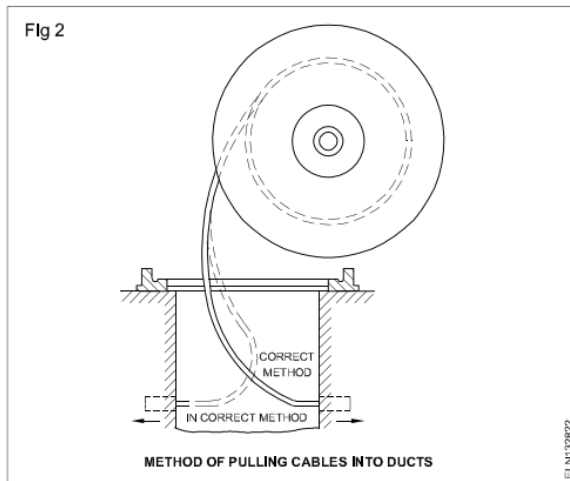
Advantages

- It is a simple and less costly method.
- It gives the best conditions for dissipating the heat generated in the cables.
- It is a clean and safe method as the cable is invisible and free from external disturbances.

Disadvantages

- The extension of load is possible only by a complete new excavation which may cost as much as the original work.
- The alterations in the cable network cannot be made easily.
- The maintenance cost is very high.
- Localisation of fault is difficult.
- It cannot be used in congested areas where excavation is difficult.

Drawing the cables into duct pipes: When drawing cables through ducts, lack of space in the drawing usually restricts the distance from the cable drum to the duct mouth. It is essential that the direction of curvature of the cables is not reversed as it enters the duct. If the cable drum is on the same side of the drawing pit, as shown in Fig 2, this condition is fulfilled.



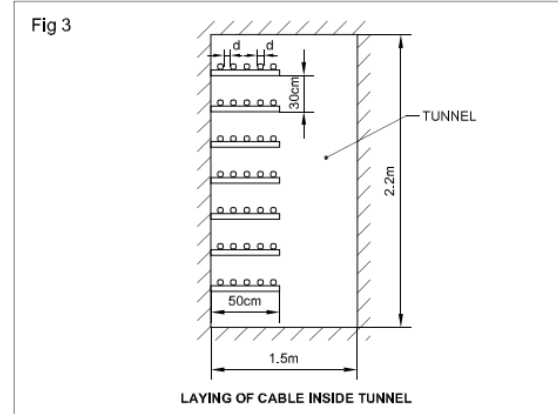
Advantages

- 1 Repairs, alterations or additions to the cable network can be made without opening the ground.
- 2 As the cables are not armoured, therefore, joints become simpler and maintenance cost is reduced considerably.
- 3 There are very less chances of fault occurrence due to strong mechanical protection provided by the system.

Disadvantages

- 1 The initial cost is very high.
- 2 The current carrying capacity of the cables is reduced due to the close grouping of cables and unfavourable conditions for dissipation of heat.

This method of cable laying is suitable for congested areas

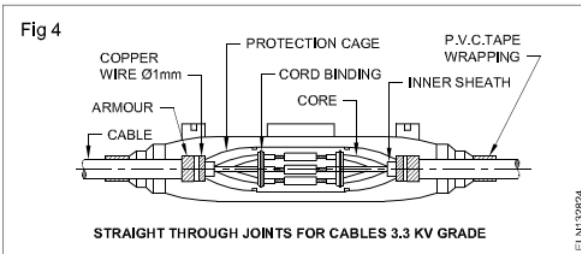


Precautions while handling cables

- 1 Prevent the cable from dragging on the floor.
- 2 Prevent kinking of the cable.
- 3 After laying the cable in the ducts it should be immediately covered or suspended.

Cable jointing methods: This process consists of the following steps.

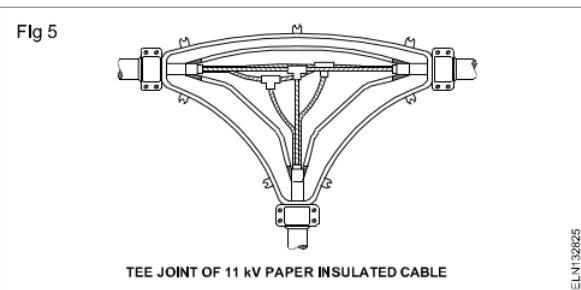
- a) Exact measurement of the cable for insulation removal.
- b) Removal of insulation.
- c) Replacing of the original insulation with high grade tapes and sleeves.
- d) Dressing the cable ends and conductor joints through sleeves/split sleeves.
- e) Providing separators between cables.
- f) Fixing a cast iron or any other protective shell around



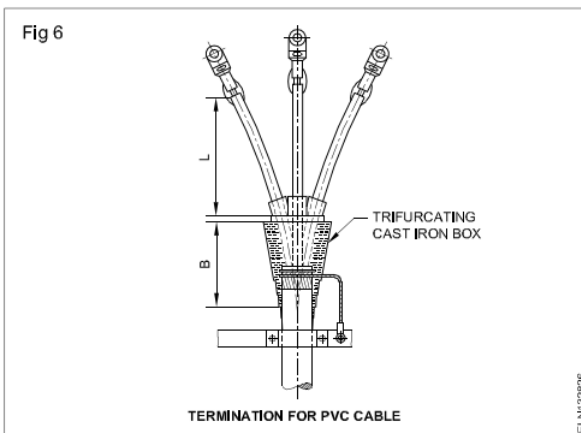
The cast iron protection boxes used up to 11 KV or moulds used for 1.1 KV joints in cast resin joints should conform to the relevant Indian Standard. Above 11 KV cast resin system is not yet standardized.

Tee joint: These joints are to be restricted up to 11 KV.

These joints are made either using cast resin kits or C.I. boxes with or without sleeves for PILC cables and cast resin kits for PVC and XLPE cables. (Fig 5)



Tri-furcating end connections: In order to connect UG cables to the air break switches etc. tri-furcating boxes are used. They can be either cast resin type up to 1.1 KV or cast iron type for 11 KV and above. This type of box is shown in Fig 6.



Method of preparing and filling compounds

- Hot pouring

- a) High electrical strength
- b) High resistance to moisture

Compounding process: Heat the compound in a special bucket on firewood or charcoal fire, stir with a clean metal rod to have even melting of the compound. Check the temperature with a thermometer and heat the compound up to 180° to 190°C.

Heat the sealing box to 70°C with a blow torch. Open all air escape plugs. Fit a heated funnel to the pouring hole. Pour the compound carefully and evenly in 2 or 3 stages with an interval between them to allow the compound to solidify. Take care that no air bubble is trapped inside.

Cold pouring compound: Cold pouring is used by using cast resin system for PVC cable jointing. This has been developed for application up to 11 KV grade cables. The compound consists of a resin base and a polyamino hardener. The two component liquids are mixed at the site in accordance with the recommendation of the manufacturer.

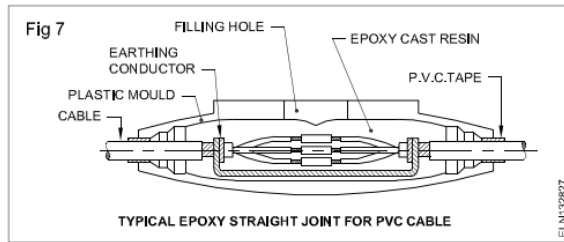
Typical epoxy straight joint for PVC cable. In this system of jointing the insulation is removed and conductors are joined. The core joints in the case of LV/MV cables should be kept apart to avoid any flash over between them. Spacers are provided between the cores for H.V. cables.

No insulation is applied over the core joints. A cover earth ring is placed tight over the two cut ends of the armour and soldered to the armour wires. The two rings are then jointed by a copper wire and the cut ends of the armouring are bent over the rings to have continuity of armour as earth conductor.

Sandpaper is applied to the inner sheath surface and is cleaned by using methyl chloride. The joint is enclosed by plastic mould, which is in two parts, whose ends are duly cut to match the size of cable. PVC tape is wrapped at the two places where the mould will touch the cables. The two halves are pasted together and kept clamped to avoid any air gap. The mould ends are enclosed with putty which is supplied in the joint kit.

The expiry date of resin is checked and the hardener added to resin. The mixture is churned thoroughly for about 15 to 20 minutes till the colour of the mixed compound becomes grey. The mix is poured slowly into the mould taking care to avoid formation of air bubbles till the mould is filled and it comes out at the risers.

Allow the joint to set for a minimum of three hours till it becomes a solid mass before charging the cable. The mould may be removed, if desired.



Types of cable faults and testing procedure

The common faults which are likely to occur in cables are:

1. **Ground fault.** The insulation of the cable may breakdown causing a flow of current from the core of the cable to the lead sheath or to the earth. This is called "Ground Fault".
2. **Short circuit fault.** If the insulation between two conductors is faulty, a current flows between them. This is called a "short circuit fault".

Methods for locating ground and short circuit faults.

The methods used localizing the ground and short circuit faults differ from those used for localizing open circuit faults.

In the case of multi core cables it is advisable, first of all, to measure the insulation resistance of each core to earth and also between cores. This enables us to sort out the core that is earthed in-case of ground fault; and to sort out the cores that are shorted in case of a short circuit fault. Loop tests are used for location of ground short circuit faults. These tests can only be used if a sound cable runs along with the faulty cable or cables.

The loop tests work on the principle of a Wheatstone bridge. The advantage of these tests is that their setup is such that the resistance of fault is connected in the battery circuit and therefore does not effect the result. However, if the fault resistance is high, the sensitivity is adversely affected. In this section only two types of tests viz., Murray and Varley loop tests are being described.

Murray Loop Test. The connection for this test are shown in Fig 8a relates to the ground fault and Fig 8b relates to the short circuit fault.

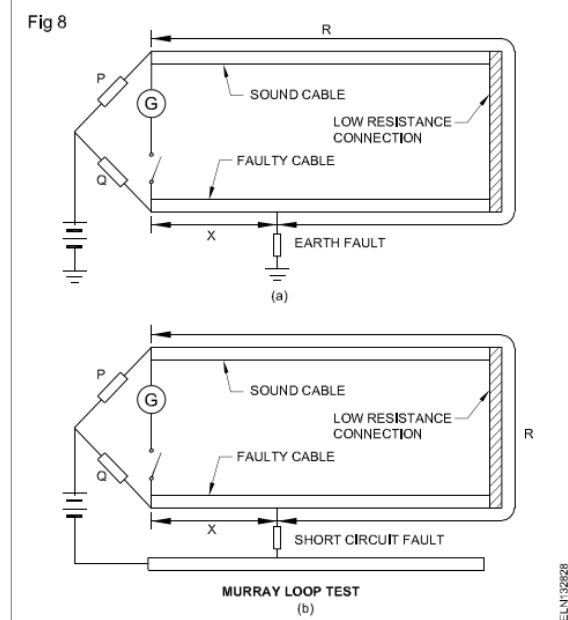
In both cases, the loop circuit formed by the cable conductors is essentially a wheatstone bridge consisting of resistances P, Q, R and X. G is a galvanometer for indication of balance,

The resistors P, Q forming the ratio arms may be decade resistance boxes or slide wires.

Under balance conditions :

$$\frac{X}{R} = \frac{Q}{P} \text{ or } \frac{X}{R+X} = \frac{Q}{P+Q}$$

$$\therefore X = \frac{Q}{P+Q} (R+X)$$



Where $(R+X)$ is total loop resistance formed by the sound cable and the faulty cable. When the conductors have the same cross-sectional area and the same resistivity, the resistance are proportional to lengths. If l_1 represents the length of the fault from the test end and l is the length of each cable. Then

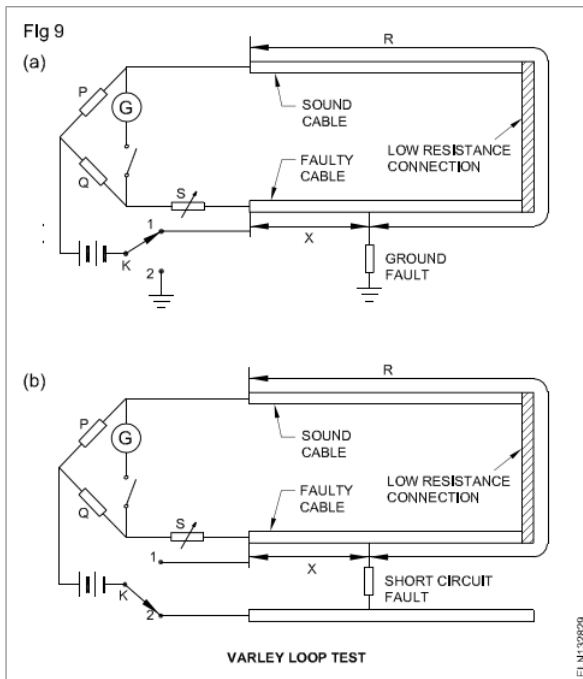
$$l_1 = \frac{Q}{P+Q} \cdot 2l$$

The above relation shows that the position of the fault may be located when the length of the cable is known. Also, the fault resistance does not alter the balance condition because its resistance enter the battery circuit hence effects only the sensitivity of the bridge circuit. However, if the magnitude of the fault resistance is high, difficulty may be experienced in obtaining the balance condition on account of decrease in sensitivity and hence accurate determination of the position of the fault may not be possible.

In such a case, the resistance of the fault may be reduced by applying a high direct or alternating voltage, in consistence with the insulation rating of the cable, on the line so as to carbonize the insulation at the point of the fault.

Varley loop test. In this test we can determine experimentally the total loop resistance instead of calculating it from the known lengths of the cable and its resistance per unit length. The necessary connections for the ground fault are shown in Fig 9a and for the short circuit fault in Fig 9b. The treatment of the problem, in both cases, is identical.

A single pole double throw switch A is used in this circuit. Switch K is first thrown to position 'I' and the resistance 'S' is varied and balance obtained.



Measurement of resistance

Let the value of S for balance be S_1 . The four arms of the Wheatstone bridge are P, Q, R + X, S_1 at balance:

$$\frac{R + X}{S_1} = \frac{P}{Q}$$

This determines R + X i.e. the total loop resistance as P, Q and S_1 are known.

The switch K is then thrown to position '2' and the bridge is rebalanced. Let the new value of S for balance be S_2 . The four arms of the bridge now are P, Q, R, X + S_2 .

At balance

$$\frac{R}{X + S_2} = \frac{P}{Q}$$

$$\frac{R + X + S_2}{X + S_2} = \frac{P + Q}{Q} \text{ or } X = \frac{(R + X)Q - S_2 P}{P + Q}$$

Hence, X is known from the known value of P, Q, S_2 , this equation and R + X (the total resistance of 2 cable determined from Eqn. knowing the value of X, the position of the fault is determined.

Now

$$\frac{X}{R + X} = \frac{l_1}{2l} \text{ or } l_1 = \frac{X}{R + X} 2l$$

Where

l_1 = length of fault from the test end and

l = total length of conductor.

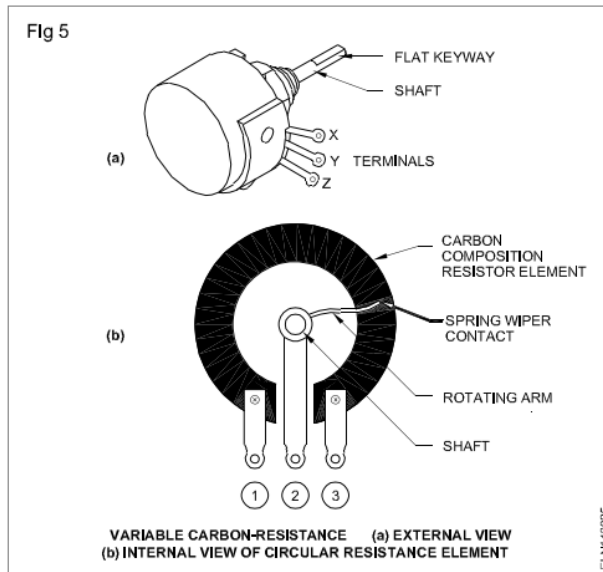
Equations for murray loop test and varley loop test are valid only when the cable sections are uniform through the loop. Corrections must be applied in case the cross-sections of faulty and sound cables are different or the cross-section of the faulty cable is not uniform over entire length.

Since temperature affects the value of resistance, corrections must be applied on this account if temperatures of the two cables are different. Corrections may also have to be applied in case the cables have a large number of joints.

2. Variable resistors

Fixed resistors : The fixed resistors is one in which the nominal value of resistance is fixed. These resistors are provided with pair of leads. (Fig 1 to 4)

Variable resistors (Fig 5) : Variable resistors are those whose values can be changed. Variable resistors includes those components in which the resistance value can be set at the different levels with the help of sliding contacts. These are known as potentiometer resistors or simply as potentiometers.



It is provided with 3 terminals as shown in Fig 5 and 6. They

PTC resistors (Sensistors) : Since, different materials have different crystal structure, the rate at which resistance increases with raising temperature varies from material to material. In PTC resistor (positive Temperature coefficient resistor), as the temperature increases, the resistance increases non-linearly. For example, the resistance of PTC resistor may be of nominal value $100\ \Omega$ at room temperature. If the temperature rises say 10°C , it may increase to $150\ \Omega$. With further increase of another 10°C , it may increase to $500\ \Omega$.

NTC Resistors (Thermistors) : In case of NTC resistor (Negative temperature coefficient resistors) as the temperature increases, the value of resistance decreases linearly. For example, NTC resistor, which has a value of resistance is $500\ \Omega$ at room temperature, may decrease to $400\ \Omega$ with the rise of 10°C temperature. Further decrease to $150\ \Omega$ when the temperature rises another 10°C .

The PTC and NTC resistors can perform switching at specific temperature. They are also used for temperature measurements and temperature compensators.

VDR (Varistors) : The VDR (Voltage dependent resistor) resistance falls non-linearly with increasing voltage. For example, a VDR, may have $100\ \Omega$ resistance at $1\ \text{V}$. It may decrease to $90\ \Omega$ at rise in $5\ \text{V}$. By further increasing the voltage to another $5\ \text{V}$, the resistance may fall to $80\ \Omega$. The VDRs are used in voltage stabilisation, arc quenching and over voltage protection.

Light dependent resistor (LDR) : The LDRs are

Charging-holding test on capacitors. In this test, a given capacitor is charged to some voltage level using an external battery as shown in Fig 12a.

Once the capacitor is charged to the applied voltage level, the battery is disconnected and the voltage across the capacitor is monitored as shown in Fig 12b. The voltage is

to monitor the holding of voltage across the charged capacitor. This is because a low ohm/volt voltmeter will draw current from the charged capacitor resulting in a early discharge of stored charges on capacitor.

Note: FET voltmeters have input resistance in the order of 6 to 10 Megohms and draws only micro ampere current for full scale deflection.

For determining values of capacitors by colour code of capacitor is given in chart-2 for reference (Fig 13).

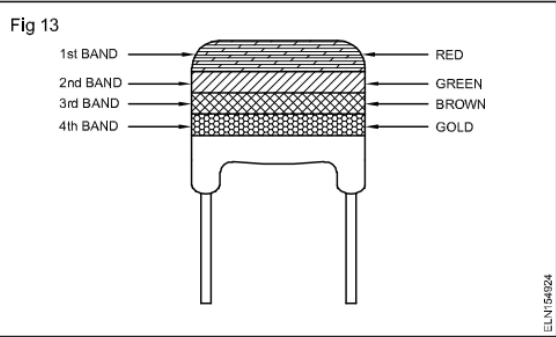
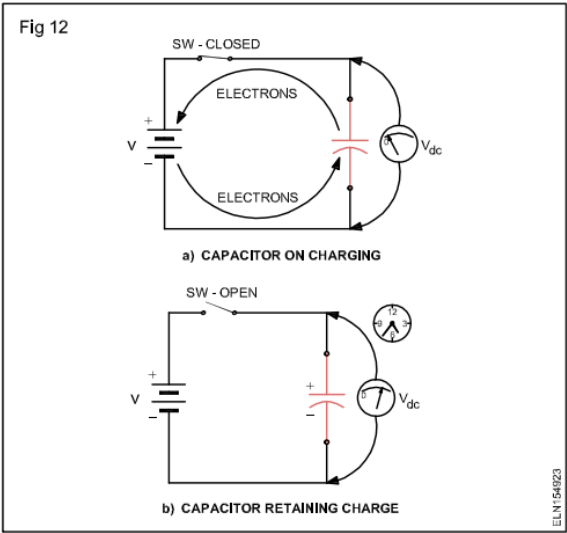
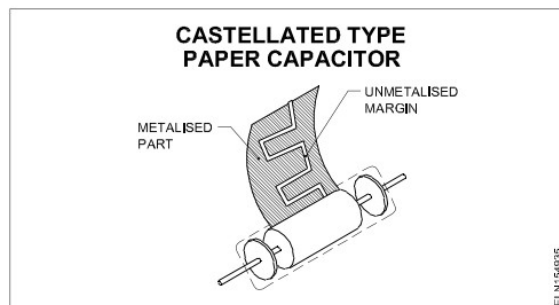
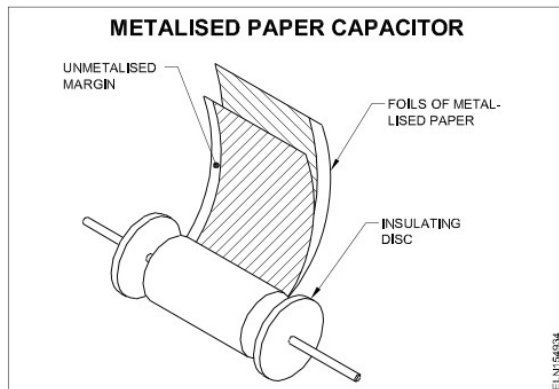
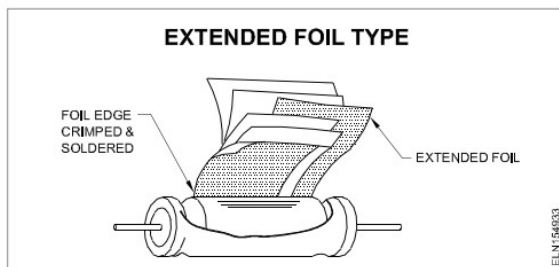
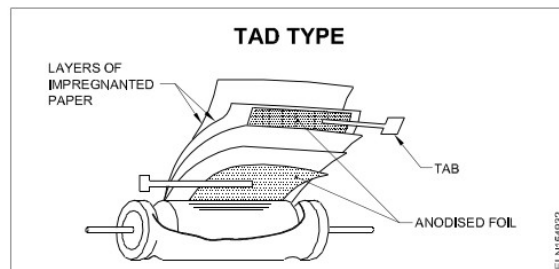
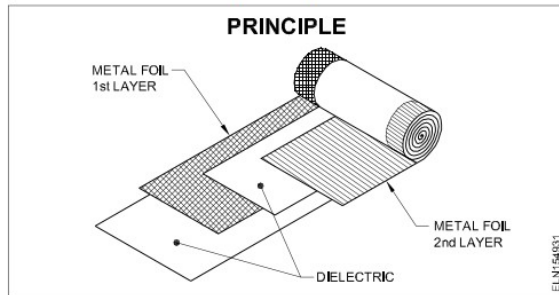
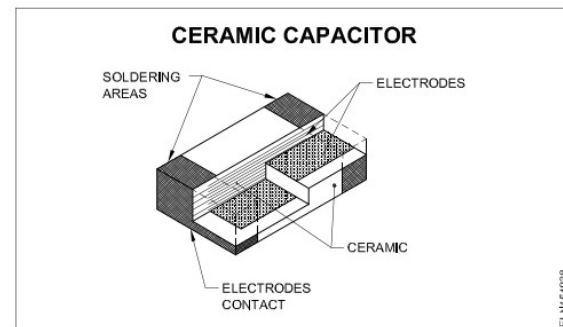
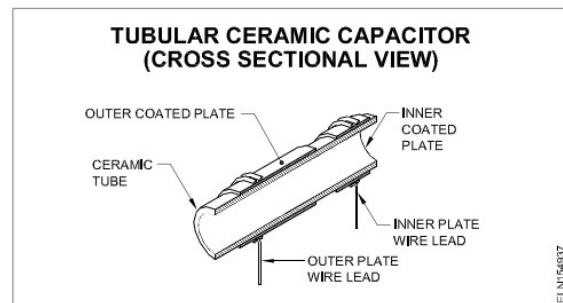
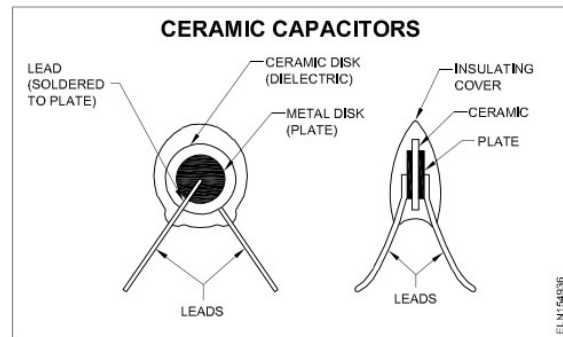


CHART - 4 Constructional details of fixed value capacitors

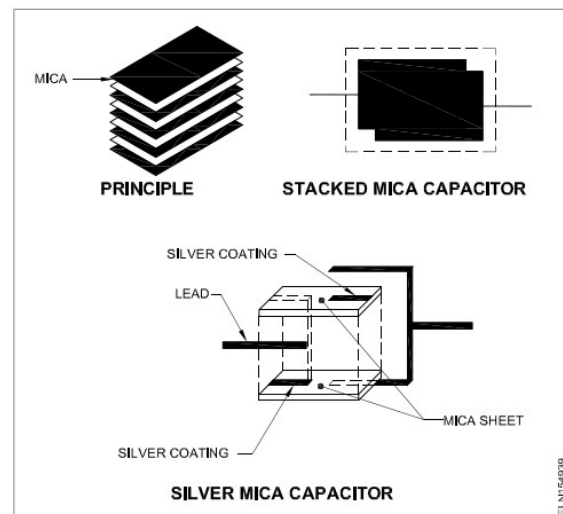
Paper Capacitors



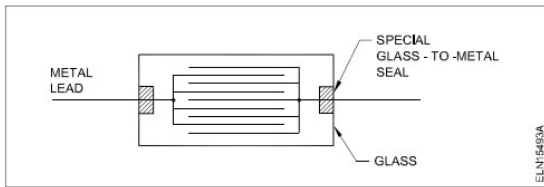
Ceramic Capacitors



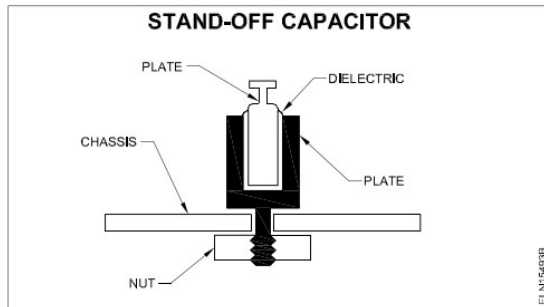
MICA Capacitors



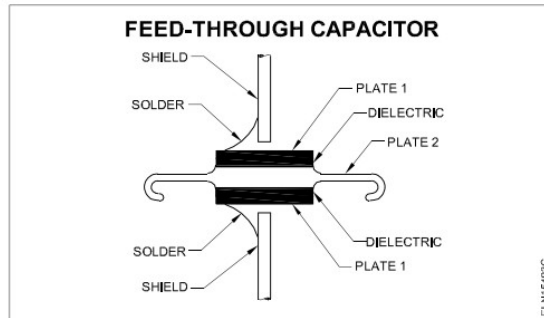
Glass Capacitors



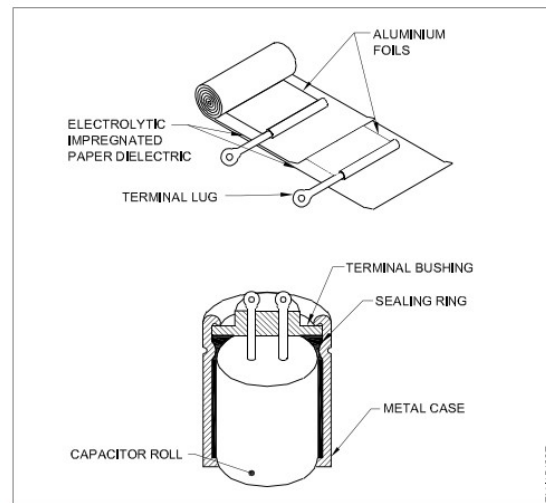
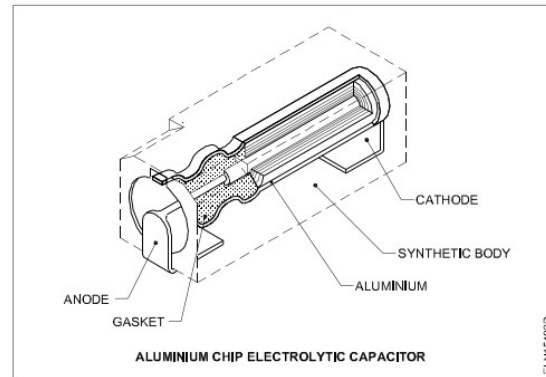
STAND-OFF CAPACITOR



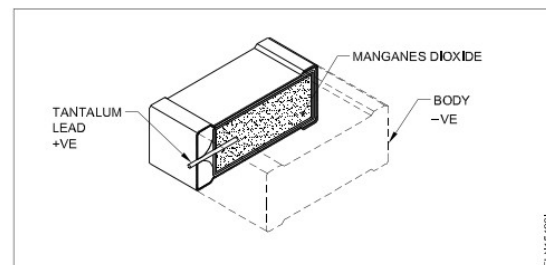
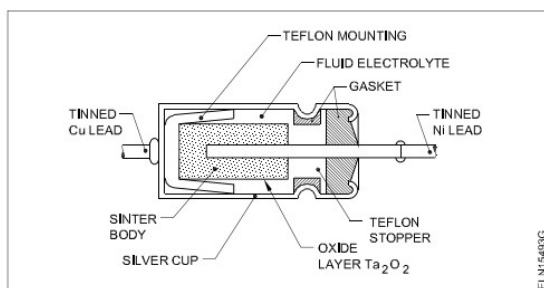
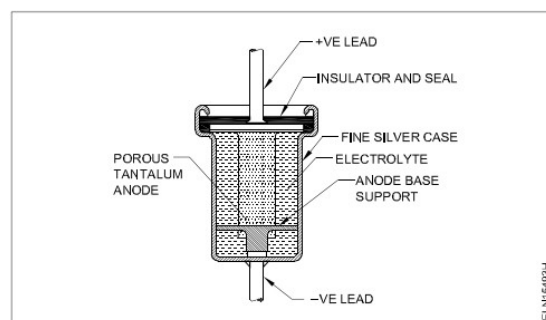
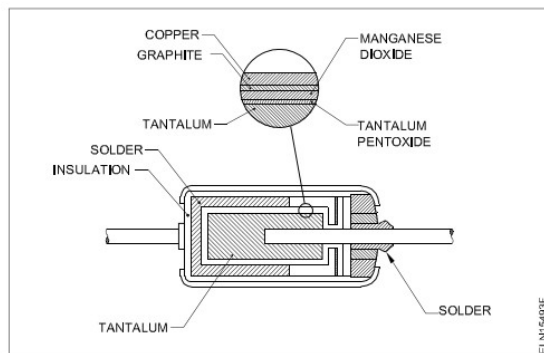
FEED-THROUGH CAPACITOR



Electrolytic Capacitors Aluminium Type



Tantalum Capacitors

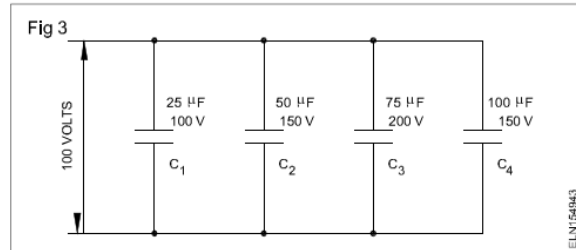


Because all the V_s terms are equal, they can be cancelled.

Therefore, $C_T = C_1 + C_2 + C_3$

Example: Calculate the total capacitance, individual charges and the total charge of the circuit given in Fig 3.

Solution



Total capacitance = C_T

$$C_T = C_1 + C_2 + C_3 + C_4$$

$$C_T = 250 \text{ micro farads.}$$

Individual charge = $Q = CV$

$$\begin{aligned} Q_1 &= C_1 V \\ &= 25 \times 100 \times 10^{-6} \\ &= 2500 \times 10^{-6} \\ &= 2.5 \times 10^{-3} \text{ coulombs.} \end{aligned}$$

$$\begin{aligned} Q_2 &= C_2 V \\ &= 50 \times 100 \times 10^{-6} \\ &= 5000 \times 10^{-6} \\ &= 5 \times 10^{-3} \text{ coulombs.} \end{aligned}$$

$$\begin{aligned} Q_3 &= C_3 V \\ &= 75 \times 100 \times 10^{-6} \\ &= 7500 \times 10^{-6} \\ &= 7.5 \times 10^{-3} \text{ coulombs.} \end{aligned}$$

$$\begin{aligned} Q_4 &= C_4 V \\ &= 100 \times 100 \times 10^{-6} \\ &= 10000 \times 10^{-6} \\ &= 10 \times 10^{-3} \text{ coulombs.} \end{aligned}$$

$$\begin{aligned} \text{Total charge} &= Q_T = Q_1 + Q_2 + Q_3 + Q_4 \\ &= (2.5 \times 10^{-3}) + (5 \times 10^{-3}) \\ &\quad + (7.5 \times 10^{-3}) + (10 \times 10^{-3}) \\ &= (2.5 + 5 + 7.5 + 10) \times 10^{-3} \\ &= 25 \times 10^{-3} \text{ coulombs.} \end{aligned}$$

$$\begin{aligned} \text{or } Q_T &= C_T V \\ &= 250 \times 10^{-6} \times 100 \\ &= 25 \times 10^{-3} \text{ coulombs.} \end{aligned}$$

Series grouping

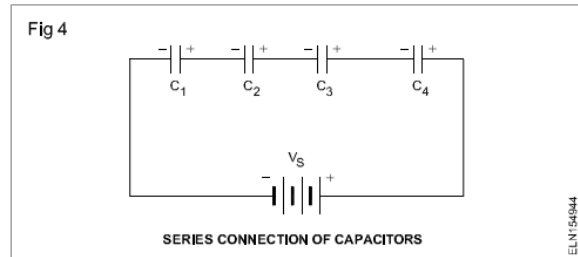
Necessity of grouping of capacitors in series: The necessity of grouping capacitors in series is to reduce the total capacitance in the circuit. Another reason is that two or more capacitors in series can withstand a higher potential difference than an individual capacitor can. But, the voltage drop across each capacitor depends upon the individual capacitance. If the capacitances are unequal, you must be careful not to exceed the breakdown voltage of any capacitor.

Conditions for series grouping

- If different voltage rating capacitors have to be connected in series, take care to see that the voltage drop across each capacitor is less than its voltage rating.
- Polarity should be maintained in the case of polarised capacitors.

Connection in series grouping: Series grouping of capacitors, as shown in Fig 4 is analogous to the connection of resistances in series or cells in series.

Total capacitance: When capacitors are connected in

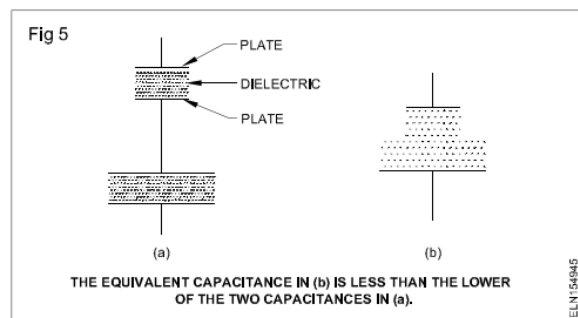


series, the total capacitance is less than the smallest capacitance value, because

- the effective plate separation thickness increases
- and the effective plate area is limited by the smaller plate.

The calculation of total series capacitance is analogous to the calculation of total resistance of parallel resistors.

By comparing Figs 5a and 5b you can understand that connecting capacitors in series increases the plate separation thickness, and also limits the effective area so as to equal that of the smaller plate capacitor.



Electrician - AC Circuits

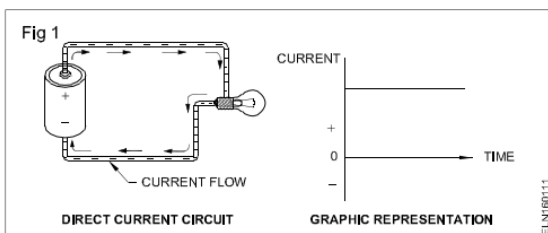
Alternating current - terms & definitions - vector diagrams

Objectives: At the end of this lesson you shall be able to

- state the features of direct current
- list out the advantages of DC over AC
- compare the features of DC and AC
- explain the generation of alternating current and terms used
- state the advantages of AC over DC

Direct current (DC): Electric current can be defined as the flow of electrons in a circuit. Based on the electron theory, electrons flow from the negative (–) polarity to the positive (+) polarity of a voltage source.

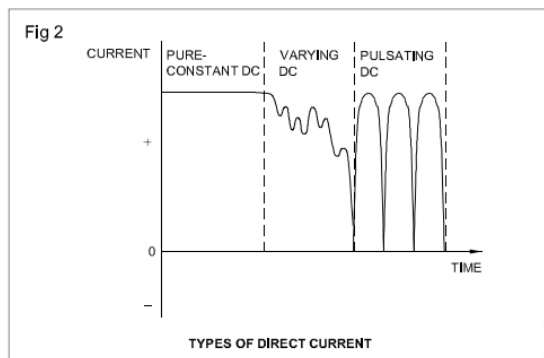
Direct current (DC) is the current that flows only in one direction in a circuit. (Fig 1) The current in this type of circuit is supplied from a DC voltage source. Since the polarity of a DC source remains fixed, the current produced by it flows in one direction only.



Dry cells are commonly used as a DC voltage source. Both the voltage and polarity of the dry cell are fixed. When connected to a load, the current produced flows in one direction at some steady or constant value.

A direct current flow need not necessarily be constant, but it must travel in the same direction at all times. There are several types of direct current, and all of them depend upon the value of the current in relation to time. (Fig 2)

A constant DC current shows no variation in value over a period of time. Both varying and pulsating DC currents have a changing value when plotted against time. The pulsating DC current variations are uniform, and repeat at regular intervals.



Advantages of DC over AC

- 1 DC needs only two wires of transmission, while a 3 phase AC may need upto 4 wires.
- 2 The corona loss associated with DC is negligible while for AC it increases with its frequency.
- 3 The skin effect is also observed in AC leading to problems in transmission conductor designs.
- 4 No inductive and capacitive losses.
- 5 No proximity effect.

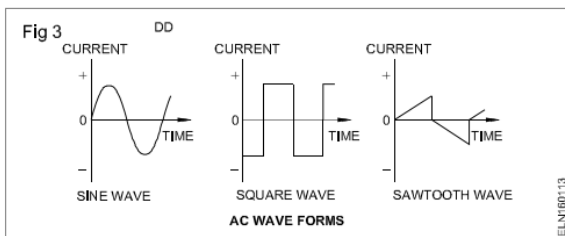
Comparison of AC and DC

	Alternating current	Direct current
Amount of energy that can be carried	Safe to transfer over longer city distances and can provide more power.	Voltage of DC cannot travel very far until it begins to lose energy.
Cause of the direction of flow of electrons	Rotating magnet along the wire.	Steady magnetism along the wire.
Frequency	The frequency of alternating current is 50Hz or 60Hz depending upon the country.	The frequency of direct current is zero.
Direction	It reverse its direction while flowing in a circuit.	It flows in one direction in the circuit.

	Alternating current	Direct current
Current	It is the current of magnitude varying with time.	It is the current of constant magnitude.
Flow of electrons	Electrons keep switching directions - forward and backward.	Electrons move steadily in one direction or 'forward'.
Obtained from	AC generator and mains.	Cell or battery.
Passive parameters	Impedence.	Resistance only.
Power factor	Lies between 0 to 1.	It is always 1.
Types	Sinusoidal, trapezoidal, triangular, square	Pure and pulsating.

Alternating current (AC): An alternating current (AC) circuit is one in which the direction and amplitude of the current flow change at regular intervals. The current in this type of circuit is supplied from an AC voltage source. The polarity of an AC source changes at regular intervals resulting in a reversal of the circuit current flow.

Alternating current usually changes in both value and direction. The current increases from zero to some maximum value, and then drops back to zero as it flows in one direction. This same pattern is then repeated as it flows in the opposite direction. The wave-form or the exact manner in which the current increases and decreases is determined by the type of AC voltage source used. (Fig 3)



Alternating current generation: Alternating current is used wherever a large amount of electrical power is required. Almost all of the electrical energy supplied for domestic and commercial purposes is alternating current.

AC voltage is used because it is much easier and cheaper to generate, and when transmitted over long distances, the power loss is low.

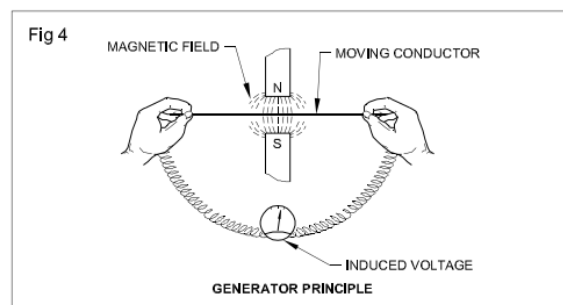
AC equipment is generally more economical to maintain and requires less space per unit of power than the DC equipment.

Alternating current can be generated at higher voltages than DC, with fewer problems of heating and arcing. Some standard values of voltages are 1.1KV, 2.2KV, 3.3KV for low capacity and 6.6KV (6600V), 11KV (11000V) and 33KV (33000V) for high capacity requirements. The values are increased to 66 000, 110 000, 220 000, 400 000 volts for transmission over long distances. At the load area, the voltage is decreased to working values of 240V and 415V.

The basic method of obtaining AC is by the use of an AC generator. A generator is a machine that uses magnetism

to convert mechanical energy into electrical energy. The generator principle, simply stated, is that a voltage is induced in a conductor whenever the conductor is moved through a magnetic field so as to cut the lines of magnetic force.

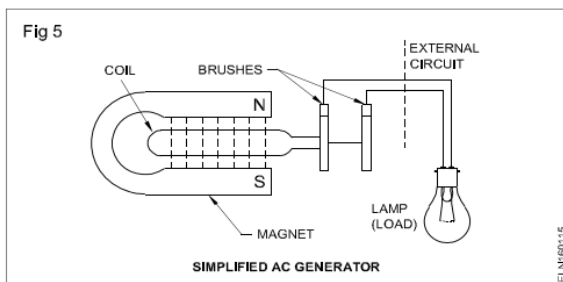
Fig 4 shows the basic generator principle. A change in a magnetic field around a conductor tends to set electrons in motion. The mere existence of a magnetic field is not enough; there must be some form of change in the field.



If we move the conductor through the magnetic field, a force is exerted by the magnetic field on each of the free electrons within the conductor. These forces add together and the effect is that voltage is generated or induced into the conductor.

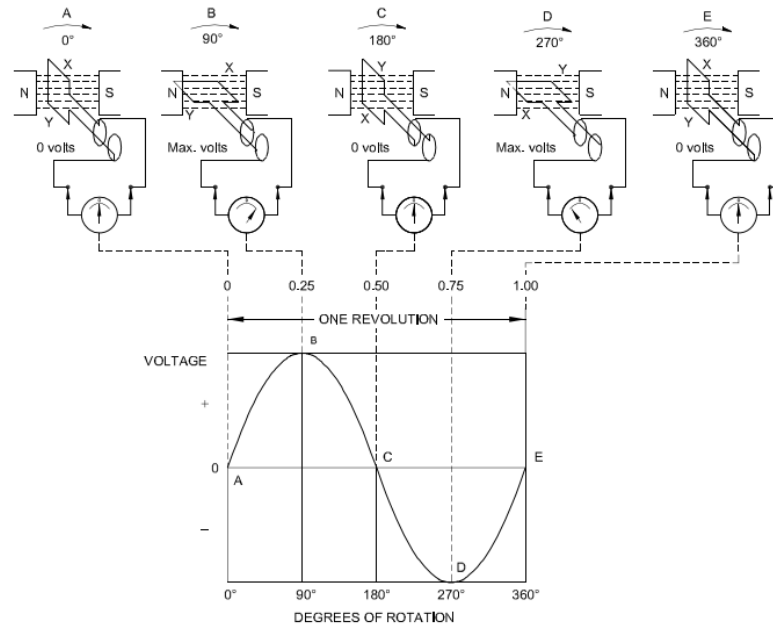
An AC generator produces an AC voltage by causing a loop of wire to turn within a magnetic field. This relative motion between the wire and the magnetic field causes a voltage to be induced between the ends of the wire. This voltage changes in magnitude and polarity as the loop is rotated within the magnetic field. (Fig 5)

The force required to turn the loop can be obtained from various sources. For example, very large AC generators are turned by steam turbines or by the movement of water.



cuts the maximum number of lines of force.

Fig 6



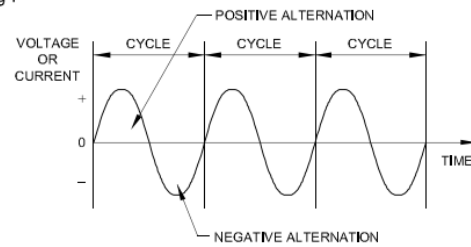
GENERATION OF AN ALTERNATING VOLTAGE: AS THE LOOP ROTATES THROUGH THE MAGNETIC FIELD, THE AMOUNT AND POLARITY OF THE VOLTAGE CHANGES WITH ANGLE AND DIRECTION OF MOTION.

ELN60116

Cycle: One cycle is one complete wave of alternating voltage or current. During the generation of one cycle of output voltage, there are two changes or alternations in the polarity of the voltage.

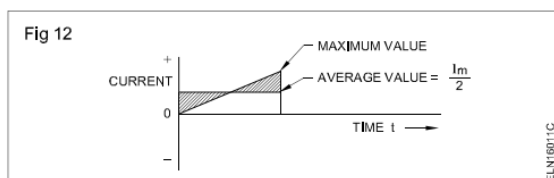
These equal but opposite halves of a complete cycle are referred to as alternations. The terms positive and negative are used to distinguish one alternation from the other. (Fig 7)

Fig 7



ELN60117

Average value: It is sometimes useful to know the average value for one half cycle. If the current is changed at the same rate over the entire half cycle as in Fig 12, the average value would be one half of the maximum value.



However, because the current does not change at the same rate, another method is used. Find the area covered by the curve over the horizontal axis, then divide that area by the base horizontal length. It has been determined that the average value is equal to 0.637 times the maximum value for sine wave-form i.e.

$$\text{for voltage, } V_{av} = 0.637 V_m$$

$$\text{for current, } I_{av} = 0.637 I_m$$

where subscript av refers to the average value and subscript m refers to the maximum value.

Form factor (k_f): Form factor is defined as the ratio of effective value to average value of half cycle.

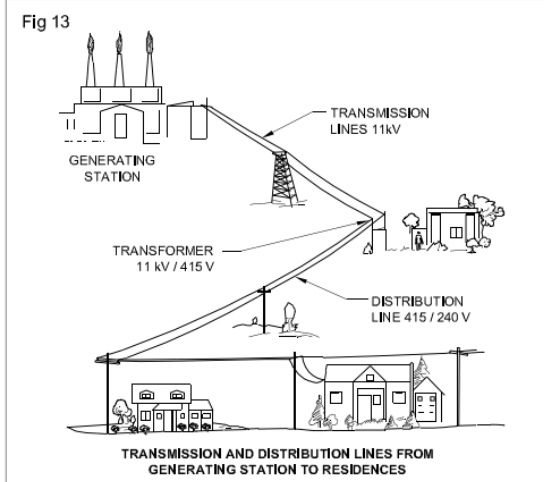
For sinusoidal AC

$$k_f = \frac{0.707 I_m}{0.637 I_m} = 1.11$$

where the subscript m refers to the maximum value.

Advantages of AC over DC:

1. AC voltages can be raised or lowered with ease. This makes it ideal for transmission purposes.
2. Large amounts of power can be transmitted at high voltage and low currents with minimum loss.
3. Because the current is low, smaller transmission wires can be used to reduce installation and maintenance costs. (Fig 13)



DC generators limit their output voltage to 6000V or less. The voltage cannot be raised or lowered through the transformers. Long distance transmission requires heavy cables. AC generators are built with a capacity up to 500000 kilowatts. The DC generators capacity is limited to 10000 kw.

AC motors are less expensive to build, install and maintain than the DC motors. DC motors have one distinct advantage over AC motors: they have better speed control.

- AC is easy to generate than DC.
- It is cheaper to generate AC than DC.
- AC generators take higher efficiency than DC.
- The loss of energy during transmission is negligible for AC in long distance.
- The AC can be easily converted to DC.
- It can easily stepup or stepdown using transformer.
- The value or magnitude of AC can be decreased easily without loss of excess of energy using choke.

Neutral and earth conductors

Objectives: At the end of this lesson you shall be able to

- describe the purpose of earthing
- describe the two types of earthing
- differentiate between 'neutral' and 'earth wire'.

Earthing: The importance of earthing lies in the fact that it deals with safety. One of the most important, but least understood, considerations in the design of electrical systems is that of earthing (grounding). The word 'earthing' comes from the fact that the technique itself involves making a low-resistance connection to the earth or to the ground. The earth can be considered to be a large conductor which is at zero potential.

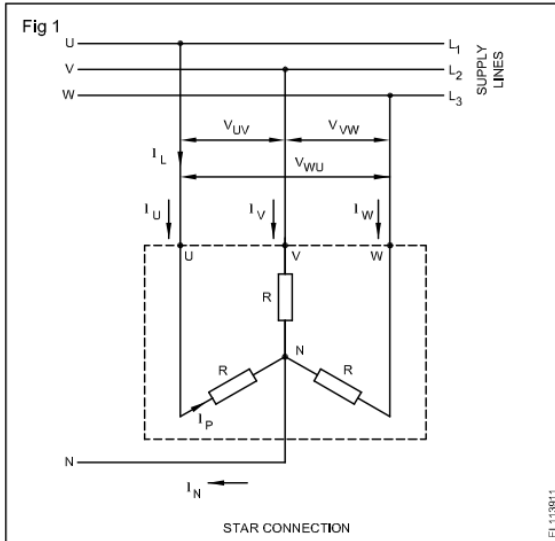
Purpose of earthing: The purpose of earthing is to provide protection to personnel, equipment and circuits

by eliminating the possibility of dangerous or excessive voltage.

There are two distinct considerations in the earthing of an electrical system: earthing of one of the conductors of the wiring system, and earthing of all metal enclosures which contain electrical wires or equipment. The two types of earthing are:

- System earthing
- Equipment earthing.

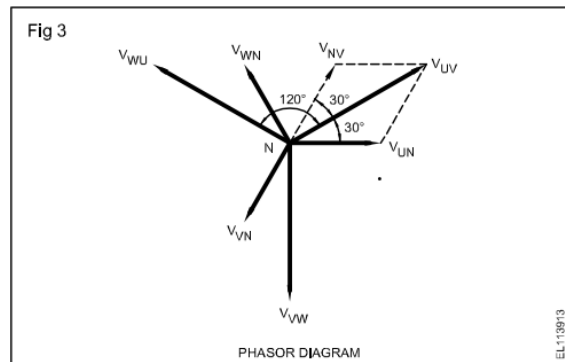
elements of the load resistance. All the elements are connected to one point N: the 'star point'. This star point is connected to the neutral conductor N. The phase currents i_U , i_V , and i_W flow through the individual elements, and the same current flows through the supply lines, i.e. in a star connected system, the supply line current (I_L) = phase current (I_P).



The potential difference for each phase, i.e. from a line to the star point, is called the phase voltage and designated as V_P . The potential difference across any two lines is called the line voltage V_L . Therefore, the voltage across each impedance of a star connection is the phase voltage V_P . The line voltage V_L appears across the load terminals U-V, V-W and W-U and designated as V_{UV} , V_{VW} and V_{WU} in the Fig 1. The line voltage in a star-connected system will be equal to the phasor sum of the positive value of one phase voltage and the negative value of the other phase voltage that exist across the two lines (Fig 2).

Thus

$$\begin{aligned} V_L &= V_{UV} = (\text{phasor } V_{UN}) - (\text{phasor } V_{VN}) \\ &= \text{phasor } V_{UN} + V_{VN} \end{aligned}$$



$$V_L = V_{UV} = V_{UN} \cos 30^\circ + V_{NV} \cos 30^\circ$$

$$\text{But } \cos 30^\circ = \frac{\sqrt{3}}{2}$$

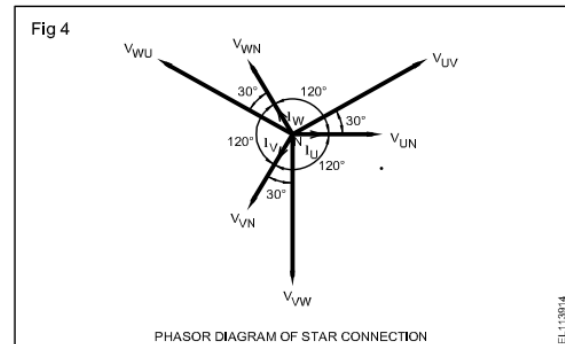
$$\text{Thus as } V_{UN} = V_{VN} = V_P$$

$$V_L = \sqrt{3} V_P$$

This same relationship is applied to V_{UV} , V_{VW} and V_{WU} .

In a three-phase star connection, the line voltage is always $\sqrt{3}$ times the phase-to-neutral voltage. The factor relating the line voltage to the phase voltage is $\sqrt{3}$ (Fig 3).

The voltage and current relationship in a star connection is shown in the phasor diagrams. (Fig 4) The phase



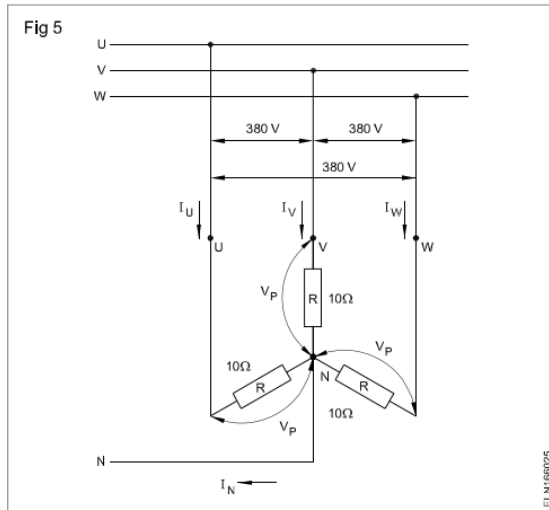
voltages are displaced 120° in phase with respect to each other.

Derived from these are the corresponding line voltages. The line voltages are displaced 120° in phase with respect to each other. Since the loads in our example are provided by purely resistive impedances, the phase currents I_P (I_U , I_V , I_W) are in phase with the phase voltages V_P (V_{UN} , V_{VN} and V_{WN}). In a star connection, each phase current is determined by the ratio of the phase voltage to the load resistance R .

Example 1: What is the line voltage for a three-phase, balanced star-connected system, having a phase voltage of 240V?

$$V_L = \sqrt{3}V_P = \sqrt{3} \times 240 \\ = 415.7V$$

Example 2: What is the magnitude of each of the supply line currents for the circuit shown in Fig 5?



Because of the arrangements of a star connection there is a voltage

$$V_P = \frac{380}{173} = 220V$$

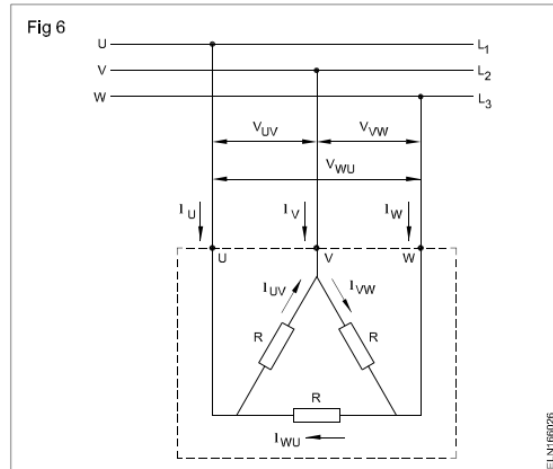
across each of the purely resistive loads R .

The three-supply line currents have the same magnitude since the star-connected load is balanced, and they are given by

$$I_U = I_V = I_W = \frac{V_P}{R} = \frac{220}{10} = 22A = I_L = I_P$$

Delta connection: There is a second possible arrangement for connecting a three-phase load in a three-phase network. This is the delta or mesh connection (Δ). (Fig 6)

The load impedances form the sides of a triangle. The terminals U, V and W are connected to the supply lines of the L_1 , L_2 and L_3 .



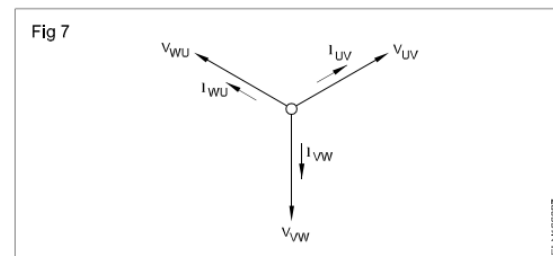
In contrast to a star connection, in a delta connection the line voltage appears across each of the load phases.

The voltages, with symbols V_{UV} , V_{VW} and V_{WU} are, therefore, the line voltages.

The phase currents through the elements in a delta arrangement are composed of I_{UV} , I_{VW} and I_{WU} . The currents from the supply lines are I_U , I_V and I_W , and one line current divides at the point of connection to produce two phase currents.

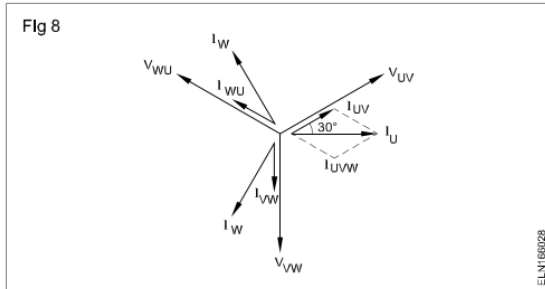
The voltage and current relationships of the delta connection can be explained with the aid of an illustration. The line voltages V_{UV} , V_{VW} and V_{WU} are directly across the load resistors, and in this case, the phase voltage is the same as the line voltage. The phasors V_{UV} , V_{VW} and V_{WU} are the line voltages. This arrangement has already been seen in relation to the star connection.

Because of the purely resistive load, the corresponding phase currents are in phase with the line voltages. (Fig 7)



Their magnitudes are determined by the ratio of the line voltage to the resistance R .

On the other hand, the line currents I_U , I_V and I_W are now compounded from the phase currents. A line current is always given by the phasor sum of the appropriate phase currents. This is shown in Fig 8. The line current I_U is the phasor sum of the phase currents I_{UV} and I_{WU} . (See also Fig 8)



Hence, $I_U = I_{UV} \cos 30^\circ + I_{WU} \cos 30^\circ$

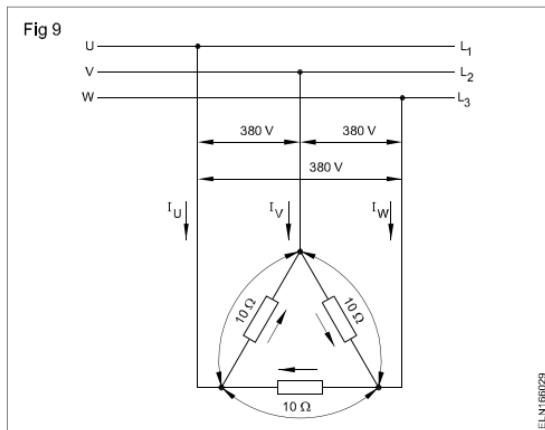
But $\cos 30^\circ = \frac{\sqrt{3}}{2}$.

Thus $I_L = \sqrt{3} I_{ph}$

Thus, for a balanced delta connection, the ratio of the line current to the phase current is $\sqrt{3}$.

Thus, line current = $\sqrt{3}$ x phase current.

Example 3: What are the values of the line currents, I_U ,



I_V and I_W in the above example? (Fig 9)

Solution

Since the load is balanced (i.e. the resistance of each phase is the same), the phase currents are of equal magnitude, and are given by the ratio of the line voltage to the load phase resistance

$$I_{UV} = I_{VW} = I_{WU} = \frac{V_P}{R} = \frac{V_L}{R} = \frac{380}{10} = 38A.$$

Thus, the phase current in the case of delta is 38A. Expressed in words:

$$\text{Phase current} = \frac{\text{line or phase voltage}}{\text{phase resistance}}$$

The line current is $\sqrt{3}$ times the phase current.

Therefore the line current is

$$I_U = I_V = I_W = \sqrt{3} \times 38A = 1.73 \times 38A = 66A.$$

Example 4: Three identical coils, each of resistance 10 ohms and inductance 20mH is delta connected across a 400-V, 50Hz, three-phase supply. Calculate the line current.

For a coil,

$$\text{reactance } X_L = 2\pi fL = 2 \times 3.142 \times 50 \times \frac{20}{1000} = 6.3 \text{ ohms.}$$

Impedance of a coil is thus given by

$$Z = \sqrt{R^2 + X^2} = \sqrt{(10^2 + 6.3^2)} = 11.8 \text{ ohms.}$$

For a delta connected system, according to equation

$$V_L = V_P.$$

$$\text{Thus } V_P = 400V.$$

Hence the phase current is given by

$$I_P = \frac{V_P}{Z} = \frac{400}{118} = 33.9 \text{ A.}$$

But for a delta connected system, according to equation,

$$I_L = \sqrt{3} I_P = \sqrt{3} \times 33.9 = 58.7A.$$

Application of star and delta connection with balanced loads

An important application is the 'star-delta change over switch' or star-delta starter.

For a particular three-phase load, the line current in a delta connection is three times as great as for a star connection for a given line voltage, i.e. for the same three-phase load (D line current) = 3 (Y - line current).

This fact is used to reduce the high starting current of a 3-phase motor with a star-delta change over switch.

Application of star connection: Alternators and secondary of distribution transformers, have their three, single-phase coils interconnected in star.

How it all works

EcoStruxure Building Expert solution offers all the building management system functionalities necessary to optimize energy efficiency and comfort in small and medium facilities. It combines a no license-fee web interface and cutting edge hardware to integrate and manage your building's systems at the lowest total cost of ownership per location.



EcoStruxure Building Expert

The software behind EcoStruxure Building Expert. It is fully programmable and includes:

Access

- Local and remote access via the LAN or web.
- Protected user-rights

Monitoring

- Dashboards
- Floorplans

Control

- Programmable using scripts or graphical programming
- Schedules, events, alarms

Scalability

- Export data for analysis
- Integration to other systems



Multi-Purpose Managers

These are the bridges between your building's systems, and your ability to control them. They combine controller, gateway, and Web server capabilities, all in one box. They can integrate a wide variety of devices and systems, using either wired or wireless communication, including: EnOcean, ZigBee, Modbus, as well as analog and binary inputs and outputs.



*Small sample of integrated products**

Controllers and Sensors

Connect, monitor and control your building's systems using controllers and sensors made specifically for your HVAC, lighting, and power systems, with an ever-growing ecosystem of integrated Schneider Electric and third-party devices.

Three-phase AC power is the standard in the United States due to its convenience of generation. Three-phase (abbreviated “3 Φ ”) power is characterized by three different phases, each with a phase shift 120° from the other two phases. The three phases are typically referred to as “A”, “B”, and “C”. Further, the standard frequency for the United States is 60 Hz. Therefore, three-phase voltages in the United States can be mathematically described as follows:

$$v_a(t) = V_{\max} \cos(360 \times 60 t) = V_{\max} \cos(21600t) \quad (2-3)$$

$$v_b(t) = V_{\max} \cos(360 \times 60 t - 120^\circ) = V_{\max} \cos(21600t - 120^\circ) \quad (2-4)$$

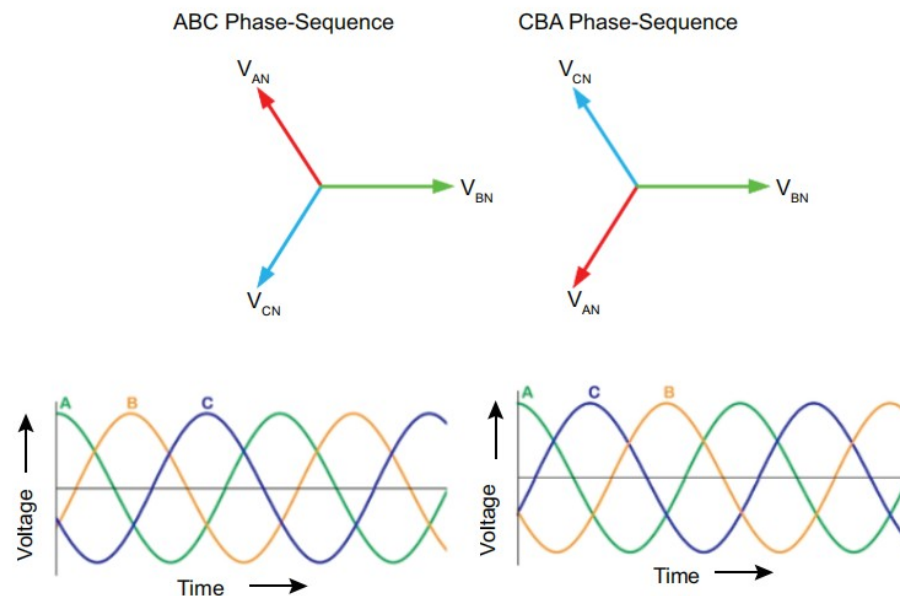
$$v_c(t) = V_{\max} \cos(360 \times 60 t + 120^\circ) = V_{\max} \cos(21600t + 120^\circ) \quad (2-5)$$

Where:

- $v_a(t)$ is the A-phase voltage
- $v_b(t)$ is the B-phase voltage
- $v_c(t)$ is the C-phase voltage

The voltages from (2-3) – (2-5) are shown graphically in Graphical Representation of 3 Φ Voltages, page 11.

Figure 2 - Graphical Representation of 3 Φ Voltages



The peaks of the voltage waveforms are 120° (5.5 ms at 60 Hz) apart. The peak of phase A occurs before the peak of phase B, which in turn occurs before the peak of phase C. This is referred to as an ABC phase sequence or ABC phase rotation. If any two-phase labels are swapped, the result is a CBA phase rotation. Both are encountered in practice. Also, the definition of time = 0 is arbitrary due to the periodic nature of the waveforms.

Because the full mathematical representation of AC voltages and currents is not practical, a shorthand notation is usually used. This shorthand notation treats the sinusoids as complex quantities based upon the following mathematical relationship:

$$\cos(\theta) = \text{Re}\{e^{j\theta}\} \quad (2-6)$$

Transformers

Transformers are vital components for AC power systems. They are used to change the voltage and current magnitudes to suit the application.

The Ideal Transformer

Transformers are relatively simple devices that utilize Faraday's law of electromagnetic induction. In its simplest form, this law can be written:

$$\xi = -N \, d\psi/dt \quad (2-35)$$

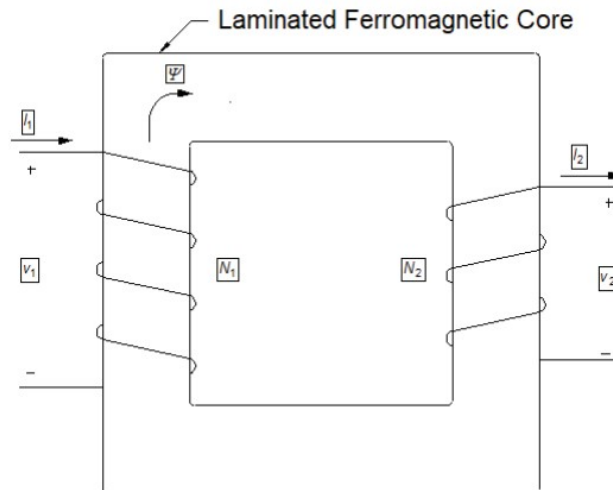
Where ξ is the voltage induced in a coil of N turns that is linked by a magnetic flux ψ .

In turn, the magnetic flux ψ for a coil of N turns through which a current I passes and linked by a magnetic path with reluctance $\mathfrak{R}$ can be expressed as:

$$\psi = NI/\mathfrak{R} \quad (2-36)$$

Consider the simple transformer shown in Basic Transformer Model, page 17:

Figure 7 - Basic Transformer Model



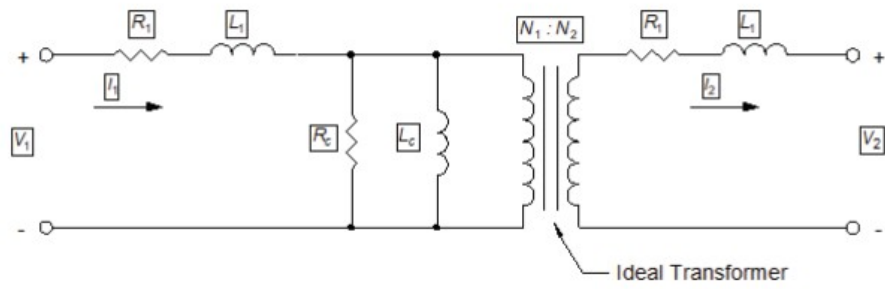
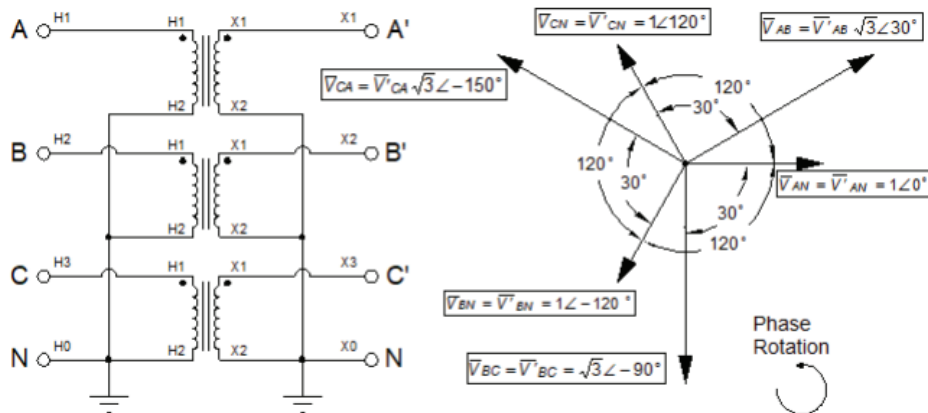


Figure 10 - Wye-Wye Transformer Connection



If a three-phase transformer is used, the wye-wye connection has the disadvantage of requiring a four-legged core to allow for a magnetic flux imbalance. Further, the solidly-grounded neutrals allow for ground currents to flow that can create interference in communications circuits (see *Electric Power Distribution System Design, New York*³). Both the primary and secondary neutrals terminals must be solidly grounded to allow for triple-harmonic currents to flow; if the neutrals are allowed to float, harmonic overvoltages are developed from phase to neutral on each winding. These overvoltages can damage the transformer insulation. Wye-wye transformers are often used on systems above 25 kV to minimize a problem known as ferroresonance. Ferroresonance is a condition which results from the transformer magnetizing impedance resonating with the upstream cable charging capacitance, resulting in destructive overvoltages as the transformer core moves into and out of saturation in a non-linear manner. Single-phase switching is usually the cause of ferroresonance.

The delta-delta connection is shown in [Delta-Delta Transformer Connection, page 20](#). There is no neutral on the delta-delta connection. A unique feature of this connection is that if one transformer is taken out of service, the two remaining transformers still provide three-phase service at a reduced capacity (57.7% of the capacity with all three transformers in service).

Figure 11 - Delta-Delta Transformer Connection

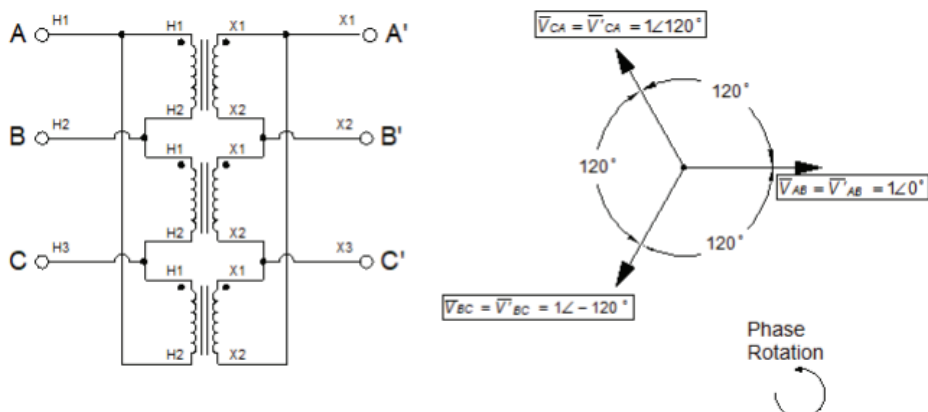
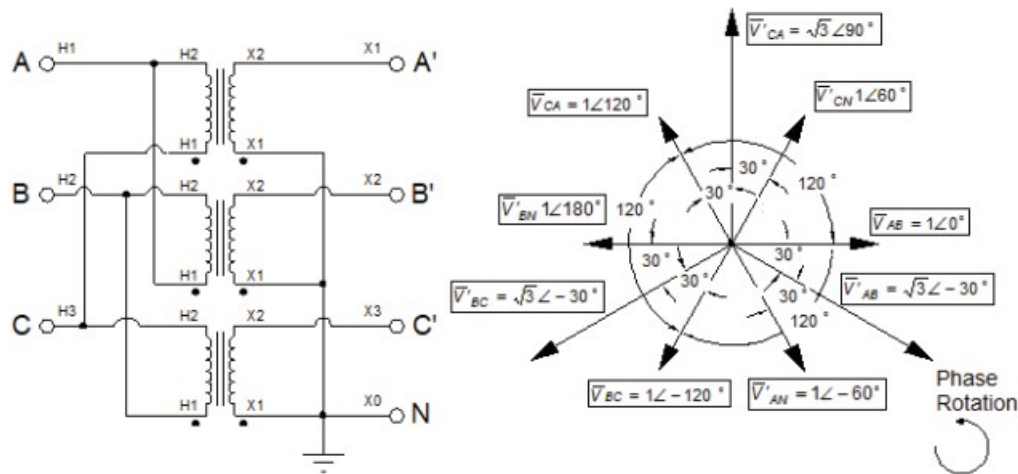


Figure 12 - Delta-Wye Transformer Connection



The wye-delta connection is shown in [Wye-Delta Transformer Connection](#), page 4. This connection is seldom used in commercial and industrial applications. The delta is arranged differently from the delta-wye connection, to satisfy the requirement from *IEEE Standard Terminal Markings and Connections for Distribution and Power Transformers*⁴ to have the phase-to-phase voltages on the low-voltage side of the transformer lag the corresponding voltages on the primary side by 30°.

Figure 13 - Wye-Delta Transformer Connection

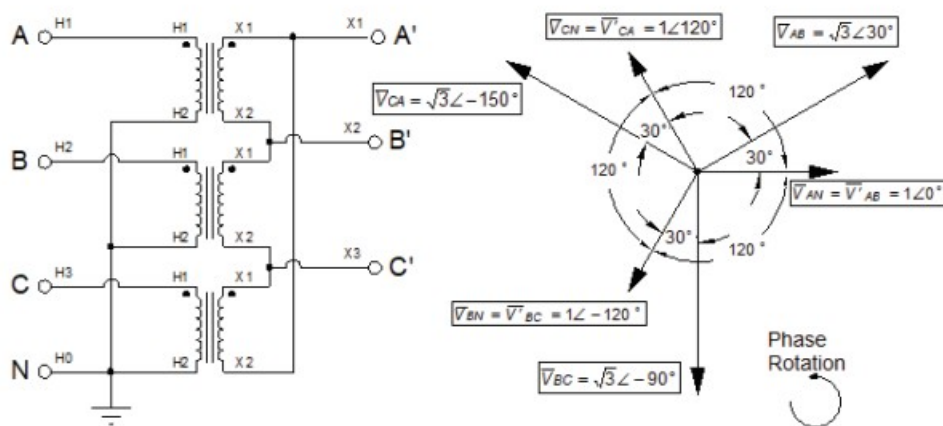
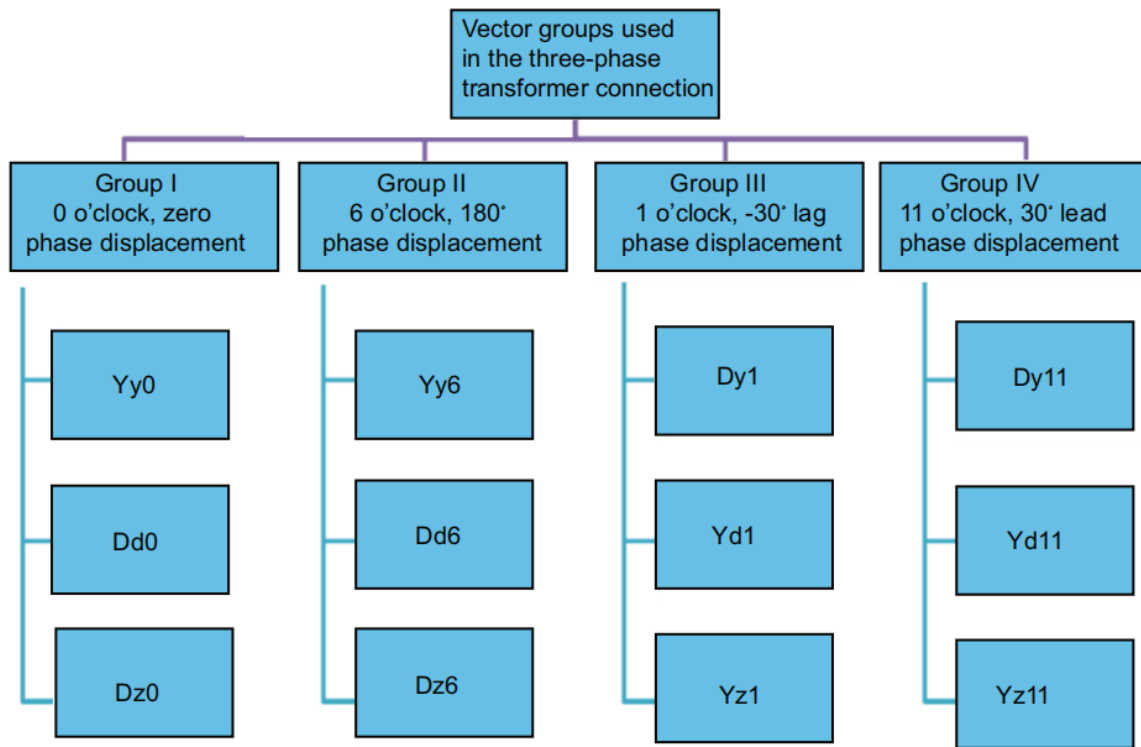


Figure 14 - Transformer Vector Group Label



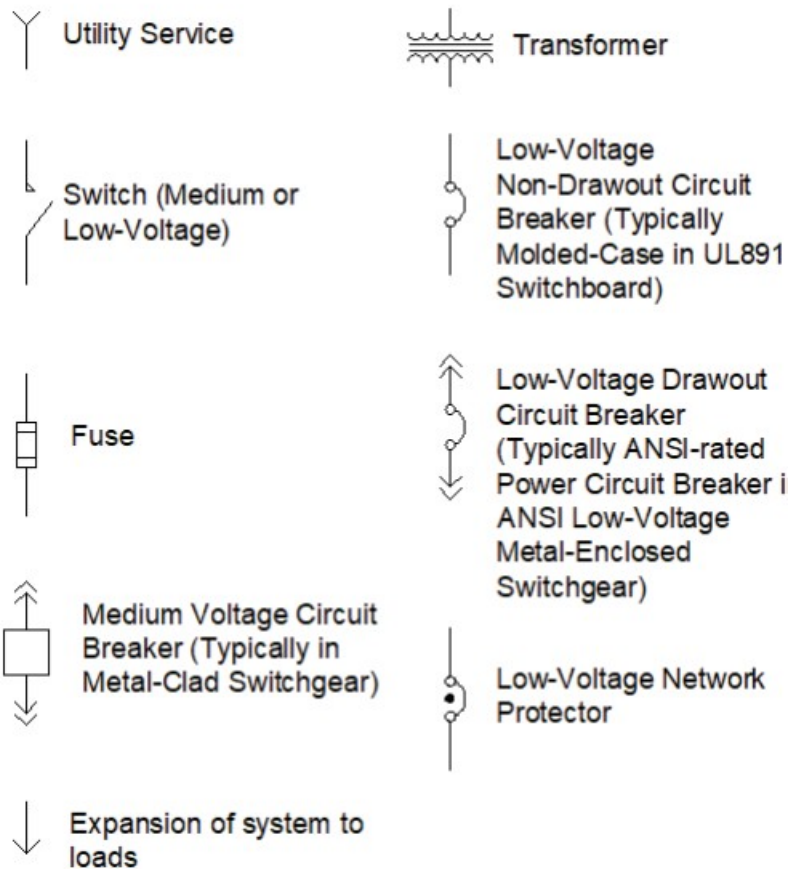
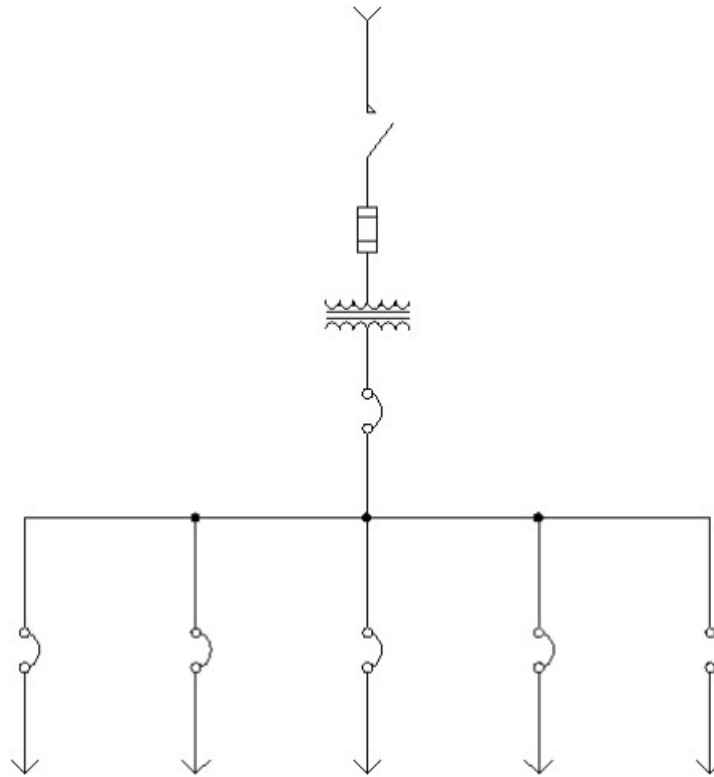


Figure 16 - Radial System



The diagram illustrates a hierarchical tree structure. At the top is a root node, represented by a square. A vertical line descends from the root node and splits into two horizontal lines, each leading to an intermediate node. Each intermediate node is represented by a square with a horizontal line through its center. Below each intermediate node is a horizontal line that splits into five vertical lines, each leading to a leaf node. Each leaf node is represented by a square with a horizontal line through its center. The entire structure is symmetrical.

Typical service entrance equipment consists of a metal-clad switchgear main circuit

Figure 25 - Secondary Spot Network

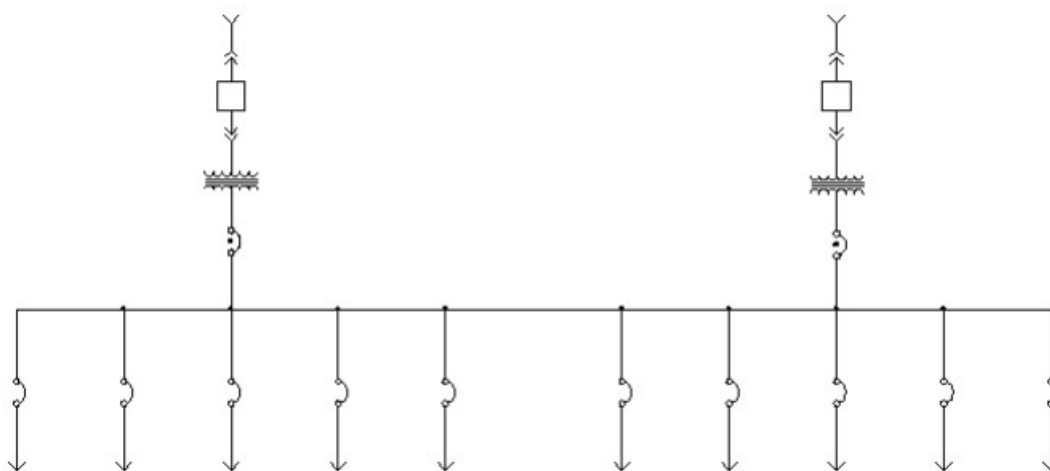


Table 6 - Power System Arrangements Summary for the Basic Arrangements in this Section

Arrangement	Utility Losses Allowed	Primary Breaker Losses Allowed	Primary Feeder Losses Allowed	Transformer Losses Allowed	Secondary Main/Tie Breaker Losses Allowed	Cost
Radial	0	0	0	0	0	\$
Radial w/ Primary Selectivity	U-1 ²³	0	0	0	0	\$+
Expanded Radial, Single Primary Feeder	0	0	0	0	0	\$\$
Expanded Radial, Multiple Primary Feeders	0	0	0	0	0	\$\$
Expanded Radial, Multiple Utility Sources, Multiple Primary Feeders	U-1 ²³	0	0	0	0	\$\$+
Primary Loop System	0	1	1	0	0	\$\$\$
Secondary-Selective System	0	0	0	1	1	\$\$\$
Transformer Sparing Scheme	0	0	0	Varies; Maximum of T, page 50-1	T, page 50 ²⁴	\$\$\$\$
Primary Selective	U-1 ^{23, 25}	PB-F-U ^{23, 25, 26}	0	0	0	\$\$\$\$\$
Secondary Spot Network	U-1 ^{23, 25, 27, 28}	PB-1 ^{23, 25, 27, 28}	F-1 ^{23, 25, 27, 28}	T, page 50-1 ^{23, 25, 27, 28}	SB-1 ^{23, 25, 27, 28}	\$\$\$\$\$
Primary Ring Bus	U-1 ^{23, 25, 29}	U ^{23, 25, 26, 29}	0	0	0	\$\$\$\$\$

Notes:

U = Number of Utility Sources

T = Number of Transformers

PB = Number of Primary Circuit Breakers

SB = Number of Secondary Main and Tie Circuit Breakers

SF = Number of Primary Feeders

\$ = Relative Cost, with \$=Least Expensive

Table 7 - Power System Arrangements Summary for the Composite Arrangements in this Section

Arrangement	Utility Losses Allowed	Primary Breaker Losses Allowed	Primary Feeder Losses Allowed	Transformer Losses Allowed	Secondary Main/Tie Breaker Losses Allowed	Cost
Primary Double Selective / Secondary Selective	U-1 ^{23, 25}	PB-F/2-U ^{23, 25, 26}	F/2	T, page 50-1 ²⁸	T, page 50-1 ^{28, 24}	\$\$\$\$\$\$\$\$
Primary Ring Bus / Primary Selective/ Secondary Selective	U-1 ^{23, 25, 27, 28}	PB-F/2-U+1 ^{23, 25, 26, 29}	F/2	T, page 50-1 ²⁸	T, page 50-1 ^{28, 24}	\$\$\$\$\$\$\$\$

Notes:

U = Number of Utility Sources

T = Number of Transformers

PB = Number of Primary Circuit Breakers

SB = Number of Secondary Main and Tie Circuit Breakers

SF = Number of Primary Feeders

\$ = Relative Cost, with \$=Least Expensive

Figure 33 - Corner-grounded Delta System Arrangement and voltage Relationships

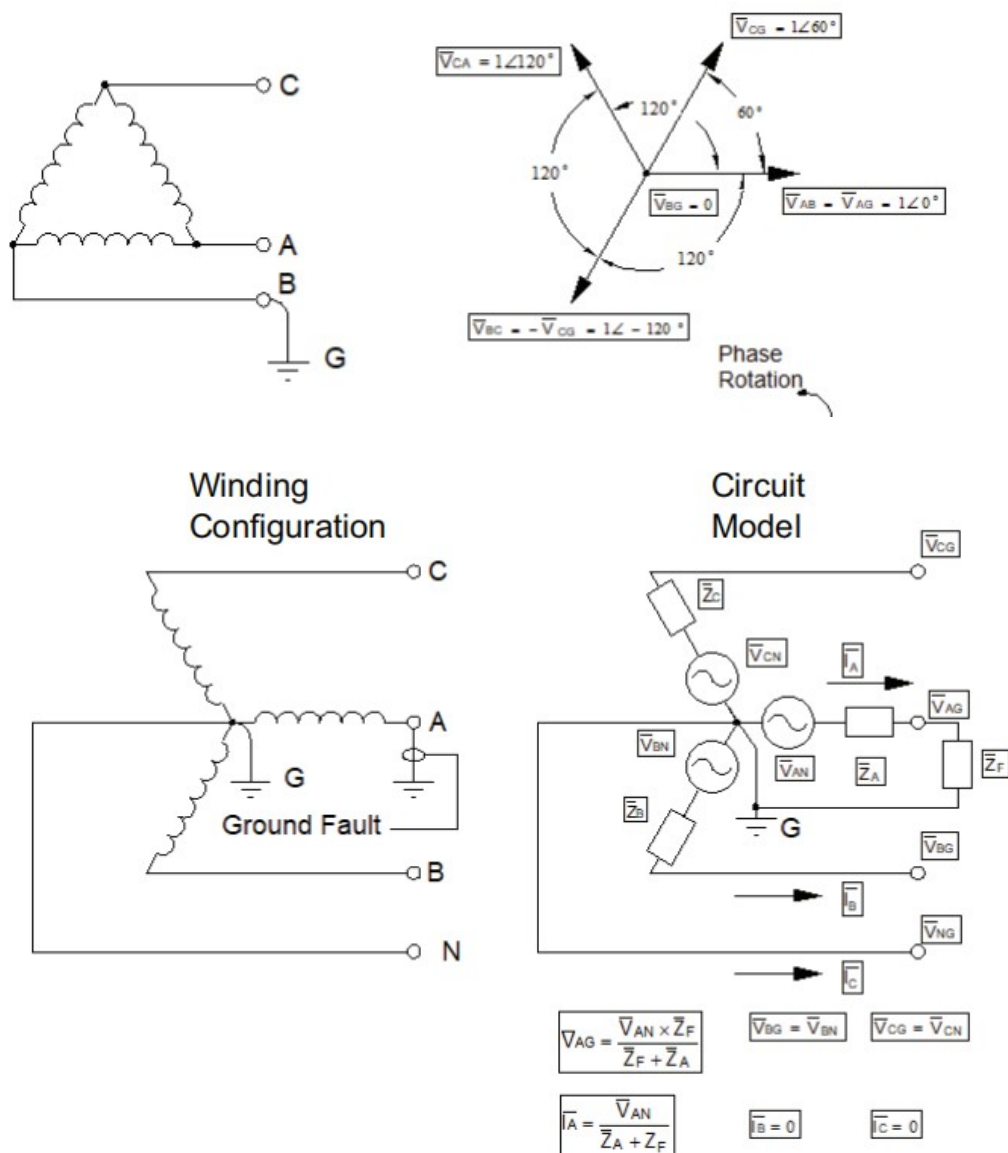


Figure 60 - Ungrounded Delta System Winding Arrangement and Voltage Relationships

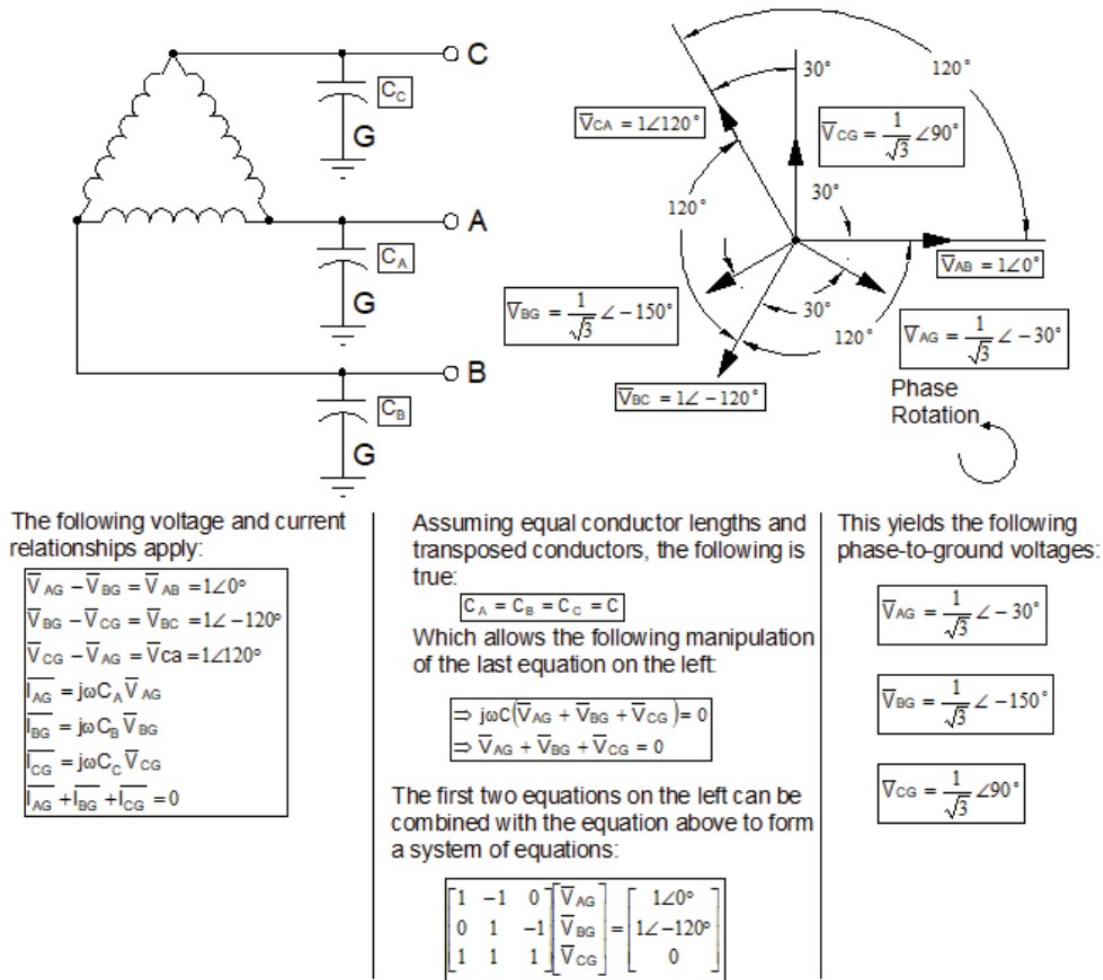
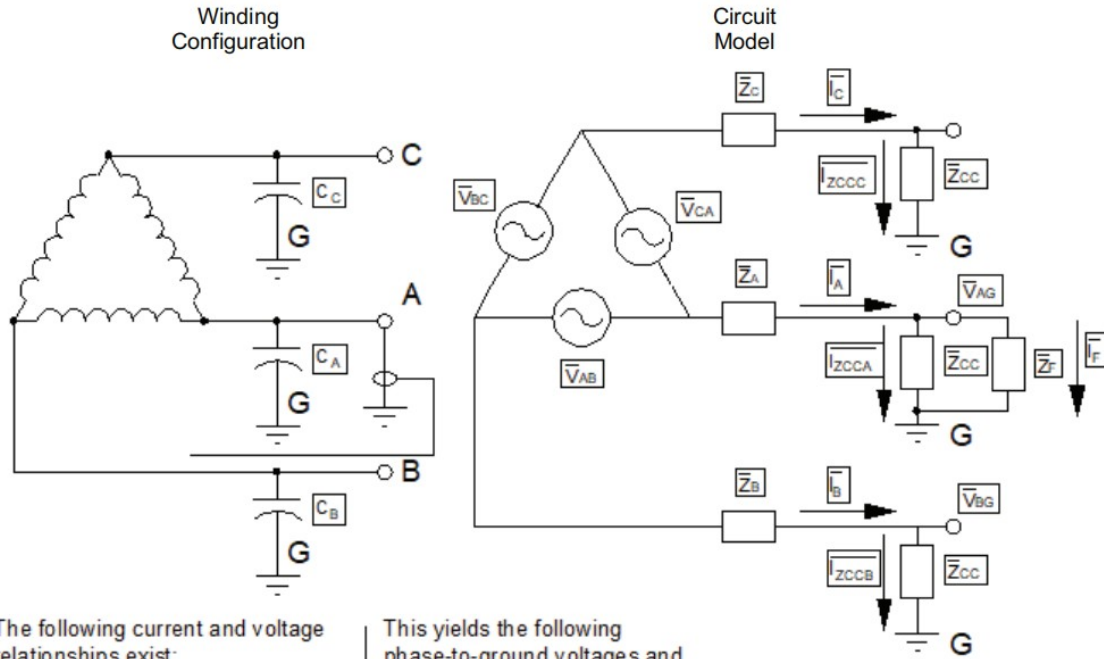


Figure 37 - Ungrounded Delta System with a Ground-current Trip on One Phase



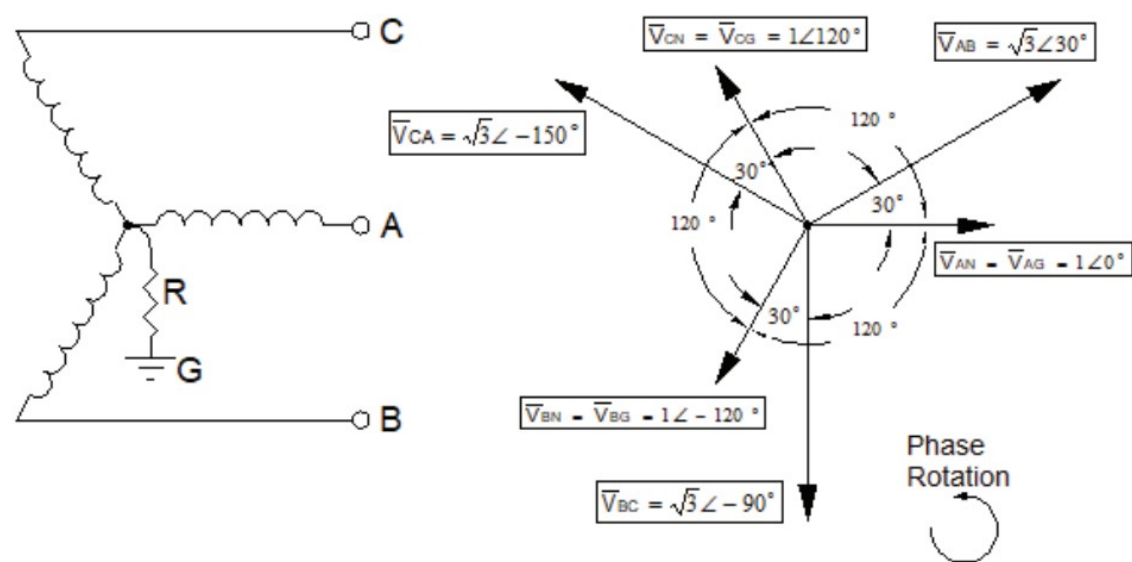
The following current and voltage relationships exist:

$$\begin{aligned} \bar{I}_A &= \frac{\bar{V}_{AG}(\bar{Z}_F + \bar{Z}_{CC})}{\bar{Z}_F \cdot \bar{Z}_{CC}} \\ \bar{I}_B &= \frac{\bar{V}_{BG}}{\bar{Z}_{CC}} \\ \bar{I}_C &= \frac{\bar{V}_{CG}}{\bar{Z}_{CC}} \\ \bar{V}_{BG} &= \bar{V}_{AG} + \bar{I}_A \cdot \bar{Z}_A + \bar{V}_{AB} - \bar{I}_B \cdot \bar{Z}_B \\ \bar{V}_{CG} &= \bar{V}_{AG} + \bar{I}_A \cdot \bar{Z}_A + \bar{V}_{AC} - \bar{I}_C \cdot \bar{Z}_C \\ \bar{I}_A + \bar{I}_B + \bar{I}_C &= 0 \end{aligned}$$

This yields the following phase-to-ground voltages and phase currents:

$$\begin{aligned} \bar{V}_{AG} &= \frac{(\bar{Z}_{CC} + \bar{Z}_C)\bar{V}_{AB} - (\bar{Z}_{CC} + \bar{Z}_B)\bar{V}_{CA} \cdot \bar{Z}_{CC} \cdot \bar{Z}_F}{\bar{Z}_A(\bar{Z}_B + \bar{Z}_C + 2\bar{Z}_{CC})\bar{Z}_{CC} + \bar{Z}_B(\bar{Z}_C \cdot \bar{Z}_{CC} + \bar{Z}_C \cdot \bar{Z}_F + \bar{Z}_{CC} + 2\bar{Z}_{CC} \cdot \bar{Z}_F) + \bar{Z}_{CC}(\bar{Z}_{CC} \cdot \bar{Z}_C + 2\bar{Z}_{CC} \cdot \bar{Z}_F + \bar{Z}_{CC} + 3\bar{Z}_F \cdot \bar{Z}_{CC})} \\ \bar{V}_{BG} &= \frac{-[(\bar{Z}_{CC} \cdot \bar{Z}_A + \bar{Z}_A \cdot \bar{Z}_F + \bar{Z}_C \cdot \bar{Z}_{CC} + \bar{Z}_C \cdot \bar{Z}_F + \bar{Z}_{CC} + 2\bar{Z}_{CC} \cdot \bar{Z}_F) \bar{V}_{AB} + (\bar{Z}_{CC} \cdot \bar{Z}_F + \bar{Z}_{CC} \cdot \bar{Z}_A + \bar{Z}_A \cdot \bar{Z}_F) \bar{V}_{CA}] \cdot \bar{Z}_{CC}}{\bar{Z}_A(\bar{Z}_B + \bar{Z}_C + 2\bar{Z}_{CC})\bar{Z}_{CC} + \bar{Z}_B(\bar{Z}_C \cdot \bar{Z}_{CC} + \bar{Z}_C \cdot \bar{Z}_F + \bar{Z}_{CC} + 2\bar{Z}_{CC} \cdot \bar{Z}_F) + \bar{Z}_{CC}(\bar{Z}_{CC} \cdot \bar{Z}_C + 2\bar{Z}_{CC} \cdot \bar{Z}_F + \bar{Z}_{CC} + 3\bar{Z}_F \cdot \bar{Z}_{CC})} \\ \bar{V}_{CG} &= \frac{[(\bar{Z}_{CC} \cdot \bar{Z}_B + \bar{Z}_{CC} \cdot \bar{Z}_A + \bar{Z}_A \cdot \bar{Z}_F) \bar{V}_{AB} + (\bar{Z}_{CC} \cdot \bar{Z}_A + \bar{Z}_A \cdot \bar{Z}_F + \bar{Z}_B \cdot \bar{Z}_{CC} + \bar{Z}_B \cdot \bar{Z}_F + \bar{Z}_{CC} + 2\bar{Z}_{CC} \cdot \bar{Z}_F) \bar{V}_{CA}] \cdot \bar{Z}_{CC}}{\bar{Z}_A(\bar{Z}_B + \bar{Z}_C + 2\bar{Z}_{CC})\bar{Z}_{CC} + \bar{Z}_B(\bar{Z}_C \cdot \bar{Z}_{CC} + \bar{Z}_C \cdot \bar{Z}_F + \bar{Z}_{CC} + 2\bar{Z}_{CC} \cdot \bar{Z}_F) + \bar{Z}_{CC}(\bar{Z}_{CC} \cdot \bar{Z}_C + 2\bar{Z}_{CC} \cdot \bar{Z}_F + \bar{Z}_{CC} + 3\bar{Z}_F \cdot \bar{Z}_{CC})} \\ \bar{I}_A &= \frac{(\bar{Z}_{CC} + \bar{Z}_C)\bar{V}_{AB} - (\bar{Z}_{CC} + \bar{Z}_B)\bar{V}_{CA}(\bar{Z}_{CC} + \bar{Z}_F)}{\bar{Z}_A(\bar{Z}_B + \bar{Z}_C + 2\bar{Z}_{CC})\bar{Z}_{CC} + \bar{Z}_B(\bar{Z}_C \cdot \bar{Z}_{CC} + \bar{Z}_C \cdot \bar{Z}_F + \bar{Z}_{CC} + 2\bar{Z}_{CC} \cdot \bar{Z}_F) + \bar{Z}_{CC}(\bar{Z}_{CC} \cdot \bar{Z}_C + 2\bar{Z}_{CC} \cdot \bar{Z}_F + \bar{Z}_{CC} + 3\bar{Z}_F \cdot \bar{Z}_{CC})} \\ \bar{I}_B &= \frac{-[(\bar{Z}_{CC} \cdot \bar{Z}_A + \bar{Z}_A \cdot \bar{Z}_F + \bar{Z}_C \cdot \bar{Z}_{CC} + \bar{Z}_C \cdot \bar{Z}_F + \bar{Z}_{CC} + 2\bar{Z}_{CC} \cdot \bar{Z}_F) \bar{V}_{AB} + (\bar{Z}_{CC} \cdot \bar{Z}_F + \bar{Z}_{CC} \cdot \bar{Z}_A + \bar{Z}_A \cdot \bar{Z}_F) \bar{V}_{CA}]}{\bar{Z}_A(\bar{Z}_B + \bar{Z}_C + 2\bar{Z}_{CC})\bar{Z}_{CC} + \bar{Z}_B(\bar{Z}_C \cdot \bar{Z}_{CC} + \bar{Z}_C \cdot \bar{Z}_F + \bar{Z}_{CC} + 2\bar{Z}_{CC} \cdot \bar{Z}_F) + \bar{Z}_{CC}(\bar{Z}_{CC} \cdot \bar{Z}_C + 2\bar{Z}_{CC} \cdot \bar{Z}_F + \bar{Z}_{CC} + 3\bar{Z}_F \cdot \bar{Z}_{CC})} \\ \bar{I}_C &= \frac{[(\bar{Z}_{CC} \cdot \bar{Z}_B + \bar{Z}_{CC} \cdot \bar{Z}_A + \bar{Z}_A \cdot \bar{Z}_F) \bar{V}_{AB} + (\bar{Z}_{CC} \cdot \bar{Z}_A + \bar{Z}_A \cdot \bar{Z}_F + \bar{Z}_B \cdot \bar{Z}_{CC} + \bar{Z}_B \cdot \bar{Z}_F + \bar{Z}_{CC} + 2\bar{Z}_{CC} \cdot \bar{Z}_F) \bar{V}_{CA}]}{\bar{Z}_A(\bar{Z}_B + \bar{Z}_C + 2\bar{Z}_{CC})\bar{Z}_{CC} + \bar{Z}_B(\bar{Z}_C \cdot \bar{Z}_{CC} + \bar{Z}_C \cdot \bar{Z}_F + \bar{Z}_{CC} + 2\bar{Z}_{CC} \cdot \bar{Z}_F) + \bar{Z}_{CC}(\bar{Z}_{CC} \cdot \bar{Z}_C + 2\bar{Z}_{CC} \cdot \bar{Z}_F + \bar{Z}_{CC} + 3\bar{Z}_F \cdot \bar{Z}_{CC})} \end{aligned}$$

Figure 40 - High-resistance Grounded System with No Ground Present



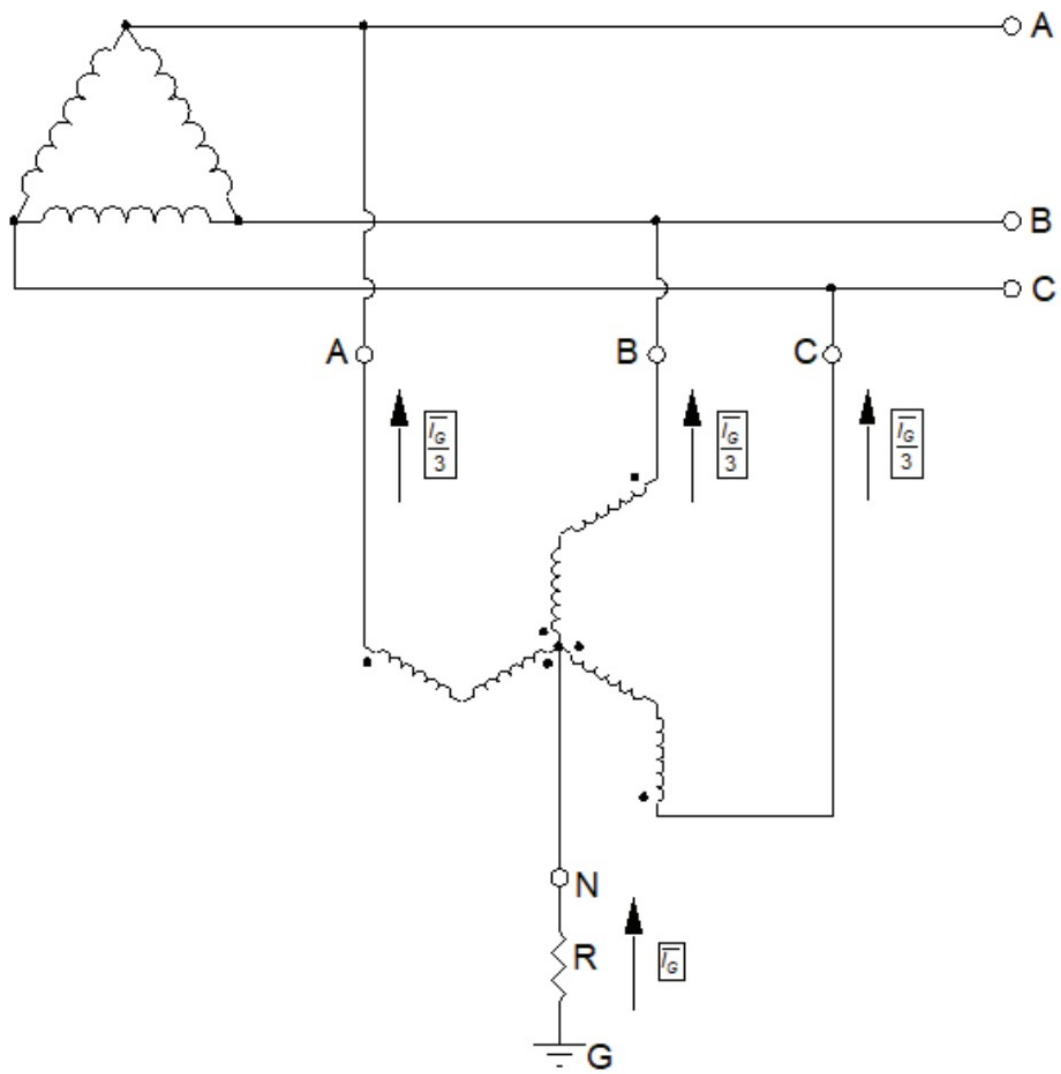


Figure 49 - Fault Current for System with Higher X/R Ratio and Closing Angle of 0, Normalized to a Steady-state Magnitude of 1

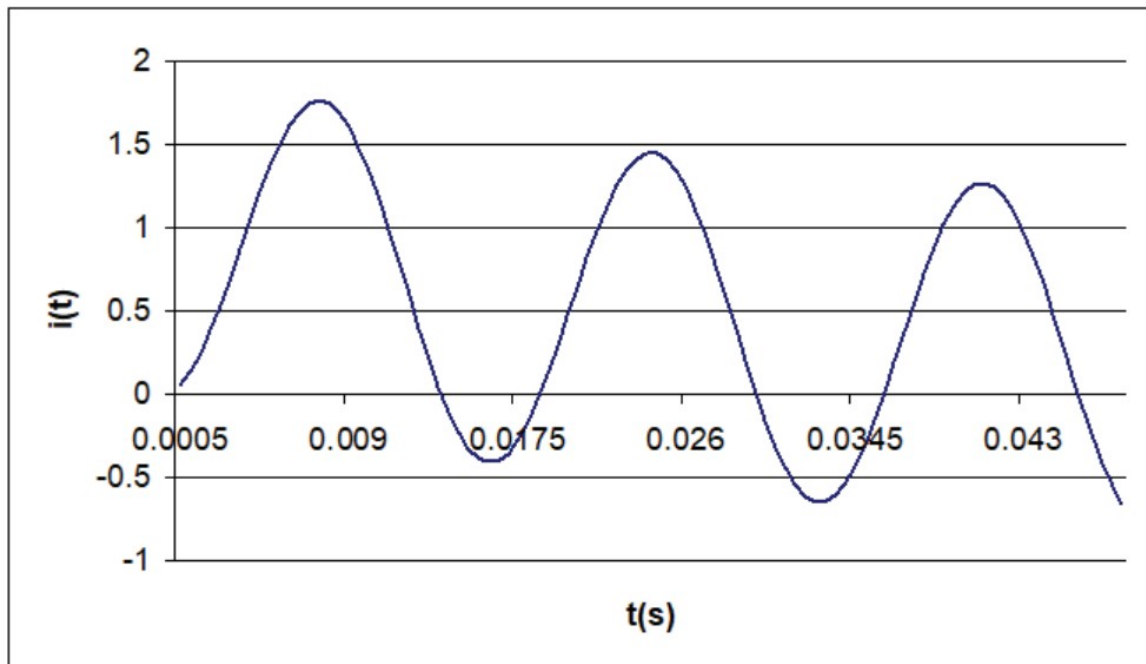


Figure 52 - ETAP Simulation for Different Cable Length

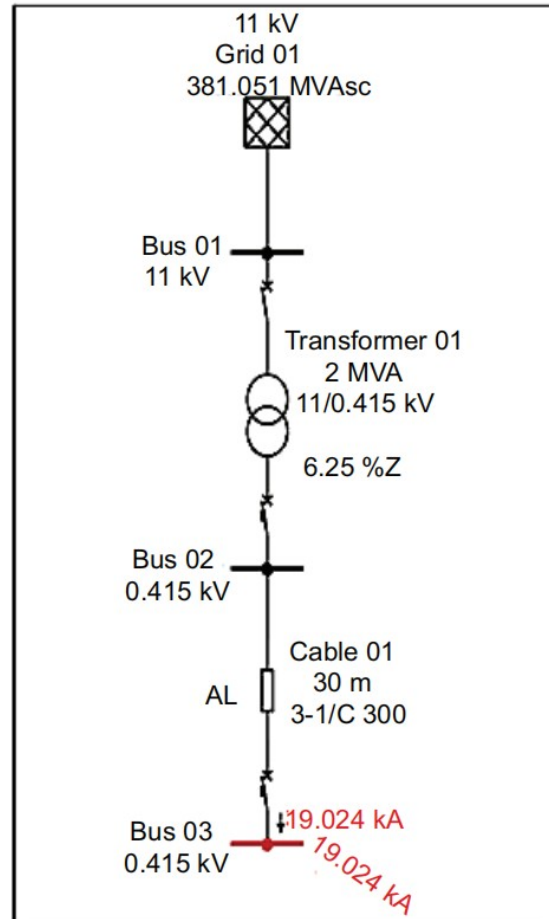
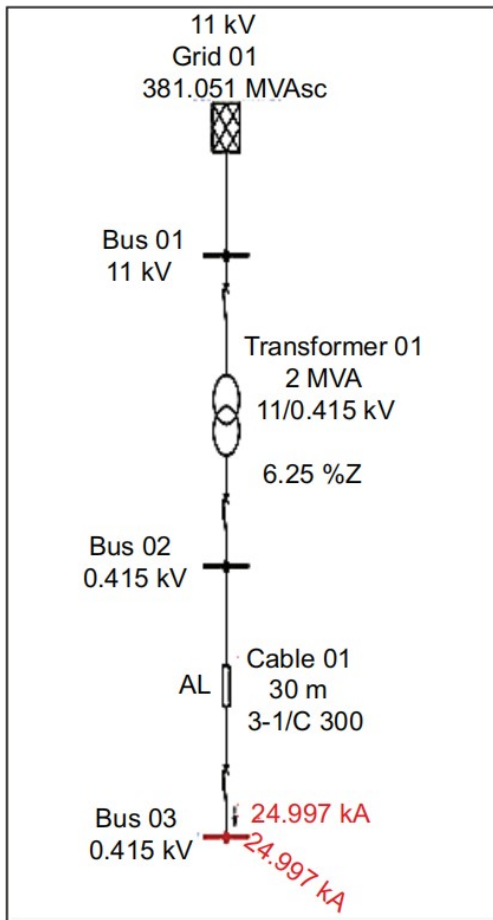
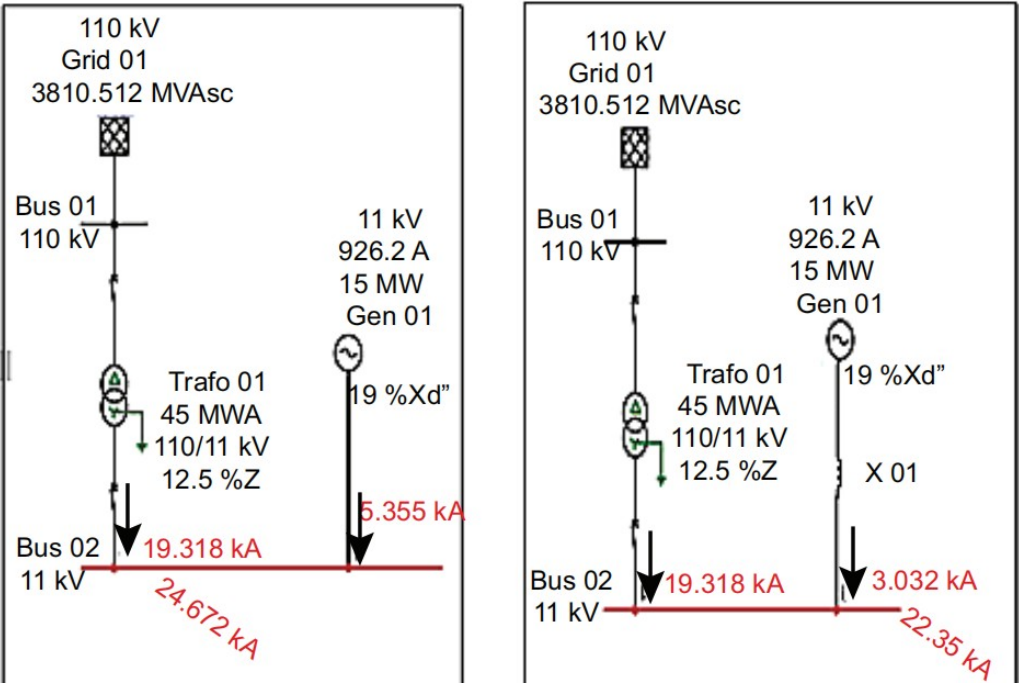
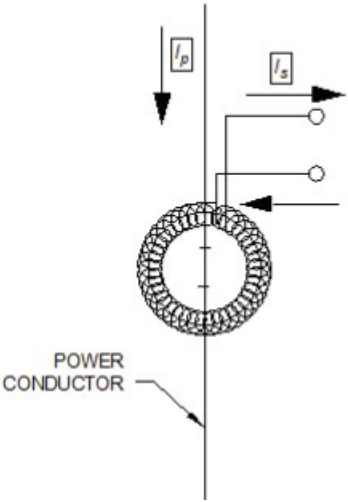


Figure 56 - With Current Limiting Reactor



Quasi-Physical
Arrangement



Circuit
Representation

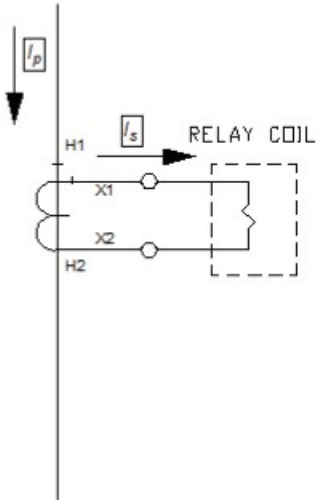


Figure 74 - Typical Application of Overcurrent Relays

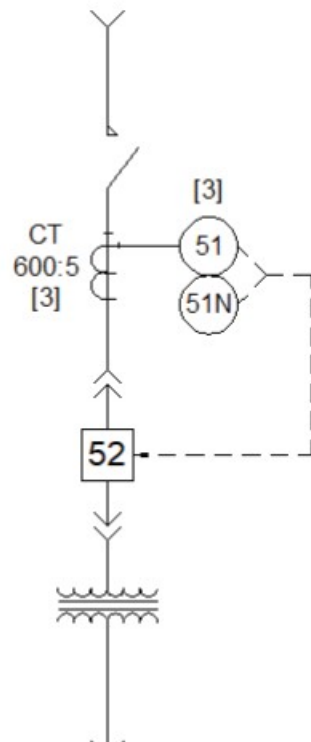


Figure 10. Example 1: relevant rooming arrangements for steady transition primary selective system.

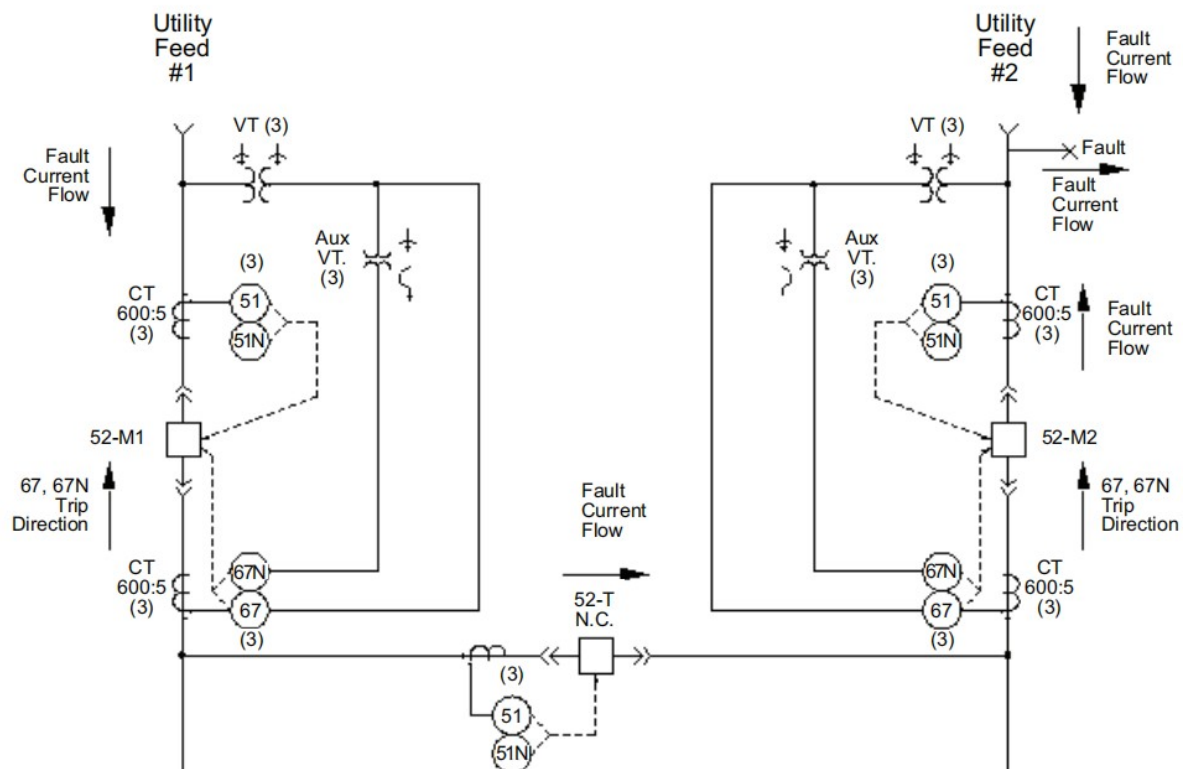


Figure 76 - Typical Application of Current-differential Relays for Delta-wye Transformer Protection

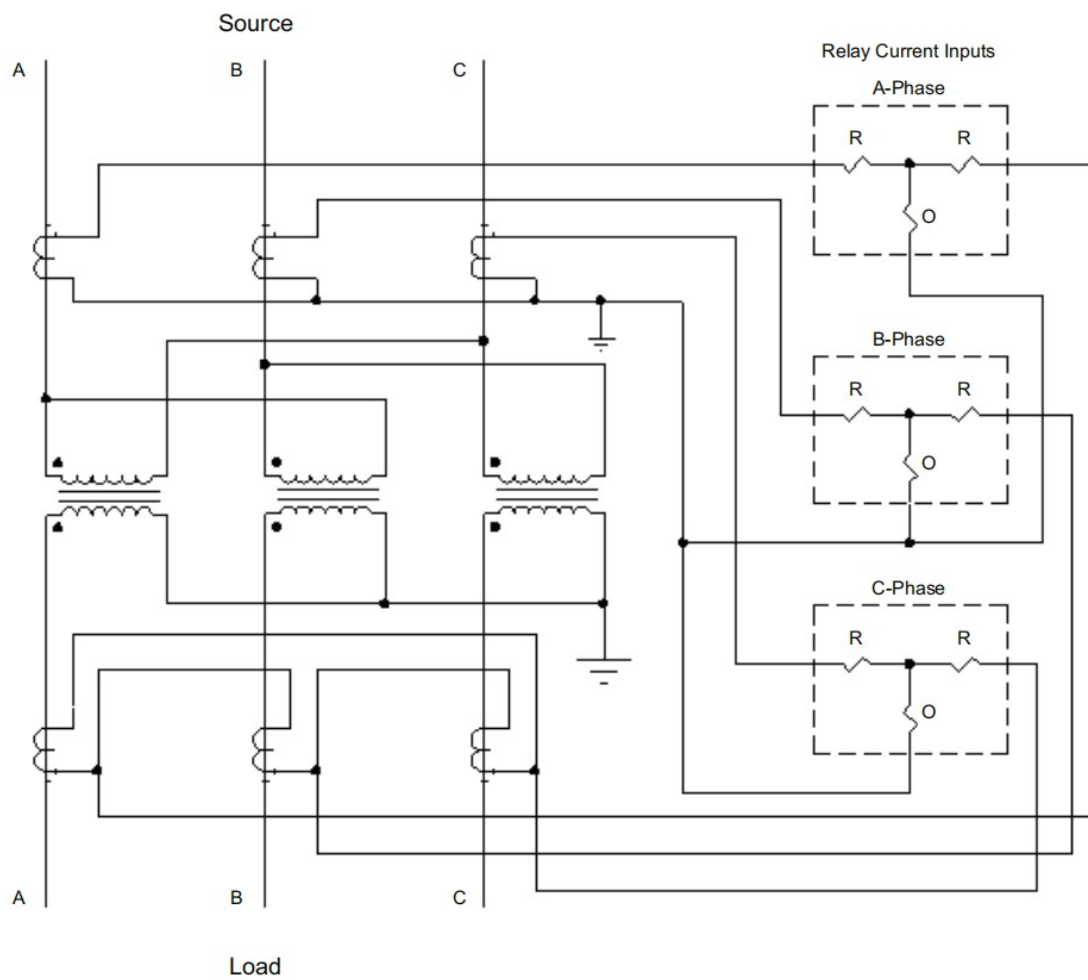


Figure 79 - High-Impedance Differential Relaying Applied to a Primary System

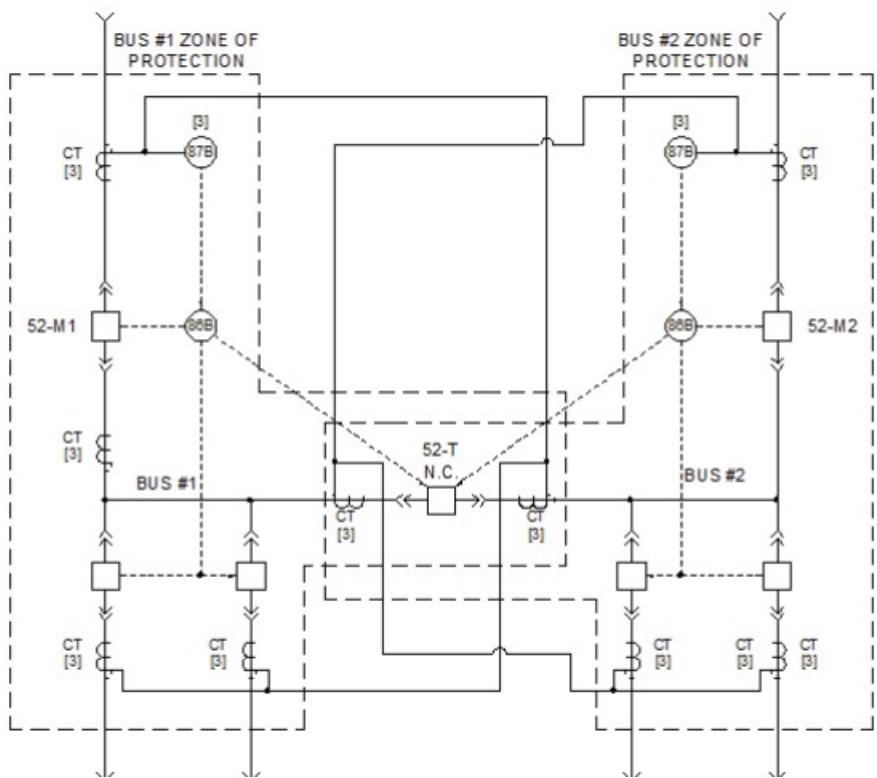
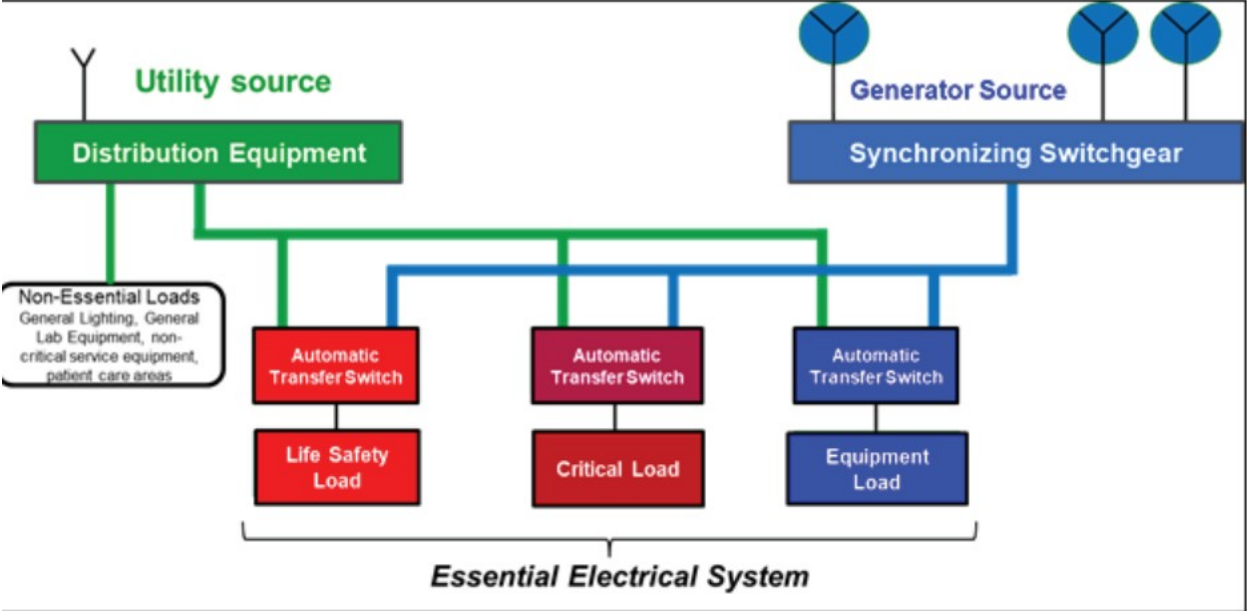
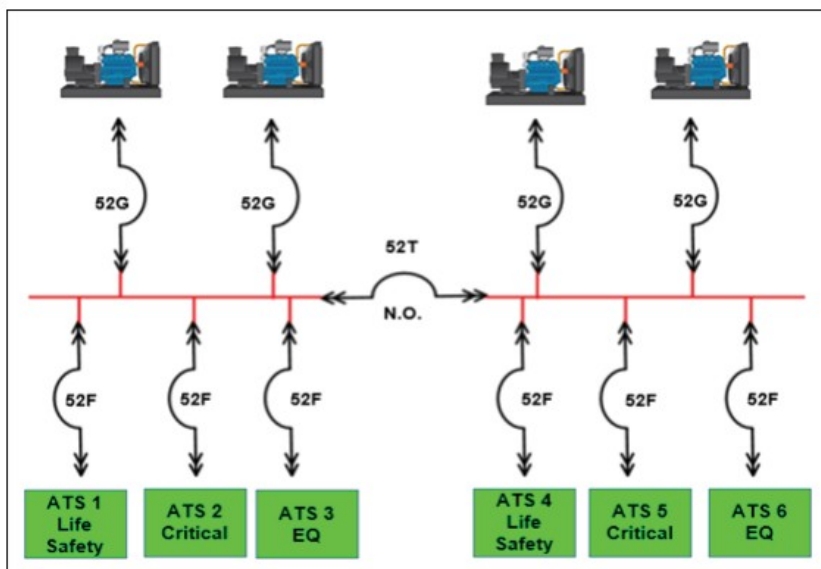


Figure 127 - Hospital Essential Electrical System with Life Safety, Critical and Equipment Branches



synchronizing device is required across the tie circuit breaker to synchronize the bus segments prior to it closing. Configurations of this type are common in healthcare applications.

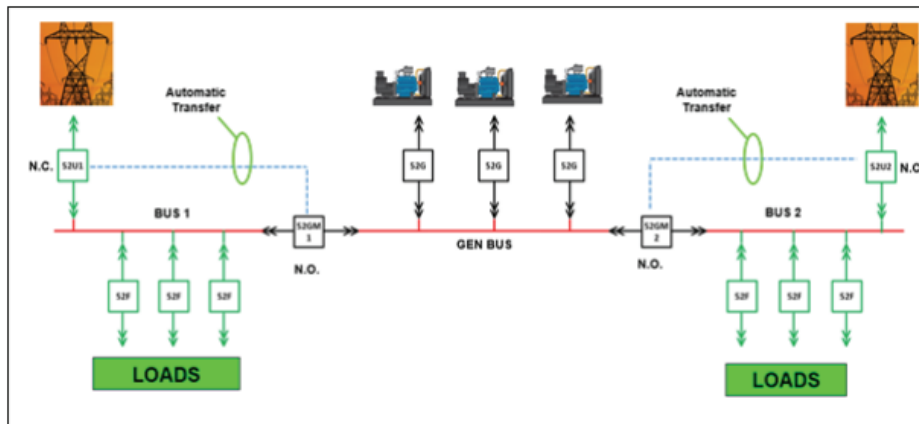
Figure 123 - Segmented Bus Configuration



Medium Voltage Main-Tie-Tie-Main Configuration with Multiple Engine Generators

A medium voltage Main – Tie – Main or Main – Tie – Tie Main system can integrate an emergency/standby system into the overall design. [More Complex Medium Voltage Main-Tie-Tie-Main system with Multiple Generators Configuration, page 203](#) illustrates the integration of a multiple engine paralleling system into a Main – Tie – Tie – Main

Figure 124 - More Complex Medium Voltage Main-Tie-Tie-Main system with Multiple Generators Configuration



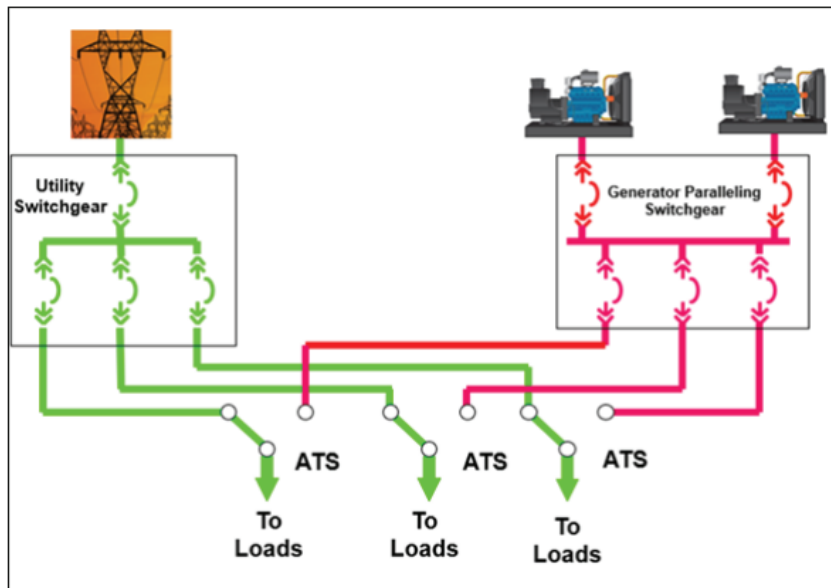
When normal power is restored, several options are available to retransfer load back to the normal source. Retransfer sequences can be open transition, closed transition or closed transition/soft load. In the example shown in [More Complex Medium Voltage Main-Tie-Tie-Main system with Multiple Generators Configuration](#), page 203 all retransfer sequences occur between the respective utility and main breakers as follow:

Open Transition Retransfer: When normal power is restored main circuit breakers 52GM1 and 52GM2 are opened and utility circuit breakers 52U1 and 52U2 are then closed in a “Break before Make” operation, assuming facility load. The engine generator circuit breakers are opened, the engine generators enter a cooldown period and then shutdown. Provide electrical Interlocks so that the respective main and utility circuit breaker pairs from both cannot be closed at the same time.

Closed Transition Retransfer: When normal power is restored main circuit breakers 52GM1 and 52GM2 remain closed. Both utilities are synchronized with the live bus via additional synchronizing devices provided for each utility. Once in synchronism circuit breakers 52U1 and 52U2 are then closed in a “Make before Break” operation. Closed transition overlap time is typically 100 milliseconds or less. Both main circuit breakers 52GM1 and 52GM2 are opened and each utility assumes facility load on its respective bus segment. The engine generator circuit breakers are opened, the engine generators enter a cooldown period and then shutdown. Additional synchronizing controls are required at each utility for closed transition operation. Benefits of closed transition operation include no interruption to loads when transferring between two acceptable sources or during system test modes.

Soft Load/Closed Transition Retransfer: Soft load sequence is similar to the closed transition sequence however the overlap time is extended, allowing load to be ramped off of the generators on onto the utility. Interconnection can be approximately 30 seconds to several minutes. Benefits are similar to closed transition but also include less wear and tear on circuit breakers and UPS systems. Utility company approval is required for soft load operation and may require specific utility approved protective relaying at each utility circuit breaker. Synchronizing devices are required at each

Figure 120 - Low Voltage Multiple Generator Paralleling System with Multiple Automatic Transfer Switches

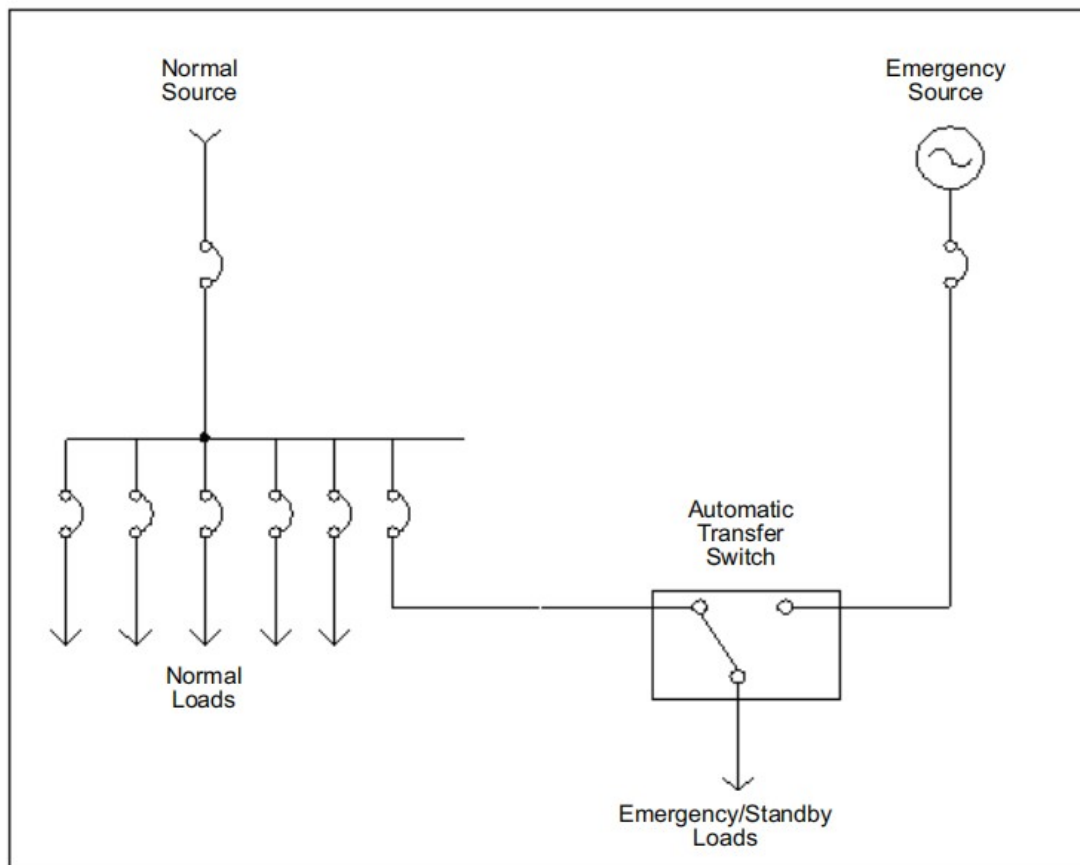


Synchronizing: Paralleling/synchronizing engine generators requires additional controls and attention must be paid to the engine generator selection. An engine typically is provided with the same kW size rating and with the same pitch. Voltage regulators and speed controls should also be matched. An automatic synchronized device is required for each engine generator. Synchronization matches a generator's speed, frequency and voltage with another source, typically another engine generator. Synchronization is necessary when connected generators together to control power surges, avoid reverse power conditions, reducing electrical stress on generators and switchgear and reduces mechanical stress and damage to prime movers. Several conditions must be met to synchronize sources:

- The number of phases must be the same.
- The direction of rotation must be the same.
- The voltage amplitudes must be closely matched ($\pm 5\%$).
- The frequencies must be closely matched (± 5 Hz).
- The phase angles must be closely matched ($\pm 5^\circ$).

Automatic Priority Load Control: In paralleling switchgear applications loads are assigned priorities so that they are added to the Emergency or Standby Power System in priority order. The highest priority loads are added first following by second highest. Typically priorities are sized in blocks to match the capacity of a single engine generator. For example, a two-engine paralleling system as shown in Low Voltage Multiple Generator Paralleling System with Multiple Automatic Transfer Switches, page 200 with two 1000 kW engines would have two priority blocks each sized to the capacity of one of the engines. If load shedding is required due to bus overload or engine loss, the lowest priority loads are shed first. Load control can be provided by operating prioritized automatic transfer switches or electrically operated circuit breakers. Automatic transfer switch load control is most common in low voltage applications. Medium voltage applications typically utilize electrically operated circuit breakers for load control. Prioritized load can be added in blocks or steps as shown in Prioritized Block Load Control and Prioritized Step Load Control, page 201.

Figure 116 - Simple Emergency/Standby System Arrangement



For Emergency Power Systems with a single alternate power source, NEC Article 700.3(F) requires a means of connecting temporary or portable power. an example is



voltage Metal-clad Switchgear

Table 42 - Medium-voltage Metal-clad Switchgear

Available Voltage Ratings	2400 V–38 kV (27 kV for SE)
Available Current Ratings	Through 3000 A (4000 A for SE)
Available Short-circuit Ratings	Through 50 kA
Major Industry Standards	ANSI/IEEE C37.20.2
Typical Enclosure Types	1, 3R

Metal-clad switchgear is defined by¹⁴⁰ as “metal-enclosed power switchgear characterized by the following necessary features:

- The main switching and interrupting device is of the removable (drawout type) arranged with a mechanism for moving it physically between connected and disconnected positions and equipped with self-aligning and self-coupling primary disconnecting devices and disconnectable control wiring connections.
- Major parts of the primary circuit, that is, the circuit switching or interrupting devices, buses, voltage transformers, and control power transformers, are completely enclosed by grounded metal barriers that have no intentional openings between compartments. Specifically included is a metal barrier in front of, or a part of, the circuit interrupting device so that, when in the connected position, no primary circuit components are exposed by the opening of a door.
- All live parts are enclosed within grounded metal compartments.
- Automatic shutters that cover primary circuit elements when the removable element is in the disconnected, test, or removed position.
- Primary bus conductors and connections are covered with insulating material throughout.
- Mechanical interlocks are provided for proper operating sequence under normal operating conditions.
- Instruments, meters, relays, secondary control devices, and their wiring are isolated by grounded metal barriers from all primary circuit elements except for short lengths of wire such as at instrument transformer terminals.



In the case of fusible equipment, overcurrent protection flexibility is limited, however with current-limiting fuses this equipment has high (up to 65 kA rms symmetrical) short-circuit interrupting capability. The load interrupter switches in this class of switchgear are designed to interrupt load currents only and may use air as the interrupting medium or SF₆. They may be arranged in many configurations of mains, but ties, and feeders as required by the application.

As for Vacuum-circuit breaker Metal-enclosed gear, all use a combination of vacuum circuit breaker and protective relays; design features like compartmentalization, bus insulation and for breakers to be withdrawable is not required by IEEE standards.

This type of switchgear is frequently used as the primary equipment of a unit substation line-up incorporating primary equipment, a transformer, and secondary equipment.

Voltage Withstand Levels for Metal-enclosed Interrupter Switchgear, page 179 shows the BIL levels of metal-enclosed interrupter switchgear, per ¹³⁸. The power frequency withstand is a one-minute test value. Momentary (ten cycle) and short-time (two seconds) current ratings are also assigned for this type of switchgear.

Table 40 - Voltage Withstand Levels for Metal-enclosed Interrupter Switchgear

Rated Maximum Voltage (kV)	Power Frequency Withstand (rms) (kV)	Impulse Withstand (kV)
4.76	19	60
8.25	36	95
15.0	36	95
27.0	60	125
38.0	80	150

Figure 101 - Low Voltage Dry-type Transformers. Left to right: Dry-type Ventilated Enclosure, Dry-type Non-ventilated Enclosure, Open Core and Coil



Additionally, the impedance of the supply system can influence the amount of inrush current the transformer can draw. To avoid tripping circuit breakers or blowing fuses on the primary side of the transformer during energizing, it is essential to carefully coordinate fuse sizes or breaker handle ratings, and magnetic trip settings. To provide optimal coordination and minimize inrush nuisance tripping, adjust the primary overcurrent protection based on the maximum inrush current. This results in the primary overcurrent protection exceeding the 125% allowance in the NEC for primary-only protection, and secondary protection is required (see 7400CT1901).

Due to concerns regarding the impact on the efficiency of the transformers and market needs for improvements in energy consumption, low voltage distribution transformers are regulated through the Energy Policy and Conservation Act (7400CT1901). The Department of Energy (DOE) evaluates and sets minimum efficiency standards for low voltage dry-type distribution transformers. Transformer efficiency can be defined as the percentage of power out compared to the percentage of power in. A perfect zero loss transformer would have the same power in as out and would be 100% efficient (see 7400CT1901). The efficiency of the transformers shall be no less than that which is required for their kVA rating, as shown in Energy Conservation Standards for Low Voltage Dry-type Distribution Transformers, page 173.

Table 34 - Energy Conservation Standards for Low Voltage Dry-type Distribution Transformers

Single Phase		Three Phase	
kVA	Efficiency %	kVA	Efficiency %
15	97.70	15	97.89
25	98.00	30	98.23
37.5	98.20	45	98.40
50	98.30	75	98.60
75	98.50	112.5	98.74
100	98.60	150	98.83
167	98.70	225	98.94
250	98.80	500	99.14

Figure 104 - Medium Voltage Power and Distribution Transformers



Medium-voltage power and distribution transformer capacities may be increased with the addition of fans. Cooling types are listed as AA (ambient air) for dry-type transformers without fans, and AA/FA (ambient air/forced air) for dry-type transformers with fans, for an increase of 33% in kVA capacity. The cooling type for a liquid-filled transformer is listed as OA for units without fans, OA/FA for units with fans, with an increase of 15% kVA capacity for units 225 - 2000 kVA, and 25% for units 2,500 – 10,000 kVA. "FFA" (future forced air) options are usually available for both dry and liquid-filled types, although experience has shown that the fans are almost never added in the field.

Typical BIL Levels for Medium-voltage Power and Distribution Transformers, page 177 gives typical BIL levels for medium-voltage power and distribution transformers. These apply to both the primary and secondary windings. Typical Design Temperature Rises for Medium-voltage Power and Distribution Transformers, page 177 gives typical design temperature rises.

Table 37 - Typical BIL Levels for Medium-voltage Power and Distribution Transformers

kV Class	VPI/VPE Dry-type BIL (kV)	Liquid-filled and Cast- resin Dry-type BIL (kV)
1.2	10	30
2.5	20	45
5.0	30	60
7.2	30	60
8.7	45	75
15.0	60	95
25.0	110	125
35.0	N/A ¹³⁶	150

Table 38 - Typical Design Temperature Rises for Medium-voltage Power and Distribution Transformers

Transformer Type	Temperature Rise (°C)
VPI/VPE Dry-type	80, 115, or 150
Cast-coil Dry-type	80 or 115
Liquid-filled	55/65 or 65

Impedance levels vary; the manufacturer must be consulted for the design impedance of a specific transformer. In general, units 1000–5000 kVA typically have 5.75% impedance $\pm$ 7.5% tolerance.

of a full flash suit is shown in Example of a Full Flash Suit, page 156.

Table 25 - Personal Protective Equipment (PPE)

Arc-flash PPE Category	PPE
1	Arc-rated Clothing, Minimum Arc Rating of 4 cal/cm2 (16.75 J/cm2)¹⁰⁰ Arc-rated long-sleeve shirt and pants or arc-rated coverall Arc-rated face shield¹⁰¹ or arc flash suit hood Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN)¹⁰² Protective Equipment Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts)¹⁰² Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR)¹⁰³ Leather footwear¹⁰⁴
2	Arc-rated Clothing, Minimum Arc Rating of 8 cal/cm2 (33.5 J/cm2)¹⁰⁰ Arc-rated long-sleeve shirt and pants or arc-rated coverall Arc-rated flash suit hood or arc-rated face shield¹⁰¹ and arc-rated balaclava Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN)¹⁰⁵ Protective Equipment Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts)¹⁰² Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR)¹⁰³ Leather footwear¹⁰⁴
3	Arc-rated Clothing Selected so that the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm2 (104.7 J/cm2)¹⁰⁰ Arc-rated long-sleeve shirt (AR) Arc-rated pants (AR) Arc-rated coverall (AR) Arc-rated arc flash suit jacket (AR)

99. NFPA 70E, The National Fire Protection Association, 2021 Edition.

100. Arc rating is defined in Article 100.

Table 25 - Personal Protective Equipment (PPE) (Continued)

	Arc-rated arc flash suit pants (AR) Arc-rated arc flash suit hood Arc-rated gloves or rubber insulating gloves with leather protectors (SR)¹⁰⁶ Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ¹⁰⁷ Protective Equipment Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts)¹⁰⁸ Leather footwear¹⁰⁹
4	Arc-Rated Clothing Selected, Minimum Arc Rating of 40 cal/cm2 (167.5 J/cm2)¹¹⁰ Arc-rated long-sleeve shirt (AR) Arc-rated pants (AR) Arc-rated coverall (AR) Arc-rated arc flash suit jacket (AR) Arc-rated arc flash suit pants (AR) Arc-rated arc flash suit hood Arc-rated gloves or rubber insulating gloves with leather protectors (SR)¹⁰⁶ Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) The arc rating of outer layers worn over arc-rated clothing as protection from the elements or for other safety purposes, and that are not used as part of a layered system, shall not be required to be equal to or greater than the estimated incident energy exposure. Protective Equipment Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts)¹⁰⁸ Leather footwear¹⁰⁹
AN: As needed (optional). AR: As required. SR: Selection required.	

Standard for Electrical Safety in the Workplace¹¹¹

Figure 94 - Example of a Full Flash Suit



106. Rubber insulating gloves with leather protectors provide arc flash protection in addition to shock protection. Higher class rubber insulating gloves with leather protectors, due to their increased material thickness, provide increased arc flash protection.

107. The arc rating of outer layers worn over arc-rated clothing as protection from the elements or for other safety purposes, and that are not used as part of a layered system, shall not be required to be equal to or greater than the estimated incident energy exposure.

108. Other types of hearing protection are permitted to be used in lieu of or in addition to ear canal inserts provided they are worn under an arc-rated arc flash suit hood.

109. Footwear other than leather or dielectric shall be permitted to be used provided it has been tested to demonstrate no ignition, melting or dripping at the minimum arc rating for the respective arc flash PPE category.

110. Arc rating is defined in Article 100.

111. NFPA 70E: The National Fire Protection Association, 2021 Edition

Table 26 - Arc Flash Mitigation Types and Impacts (Continued)

Remote racking system	Yes	No	Yes 119	N/A	None	None	Easily	\$	\$
Partial de-energization / load redundancy multiple sources (Main-Tie-Main)	Limited	Limited	Limited	Partial operation hours / days	High	Medium	Difficult	\$\$	\$

Table 27 - Prevention Methods That Reduce Arc Flash Risk

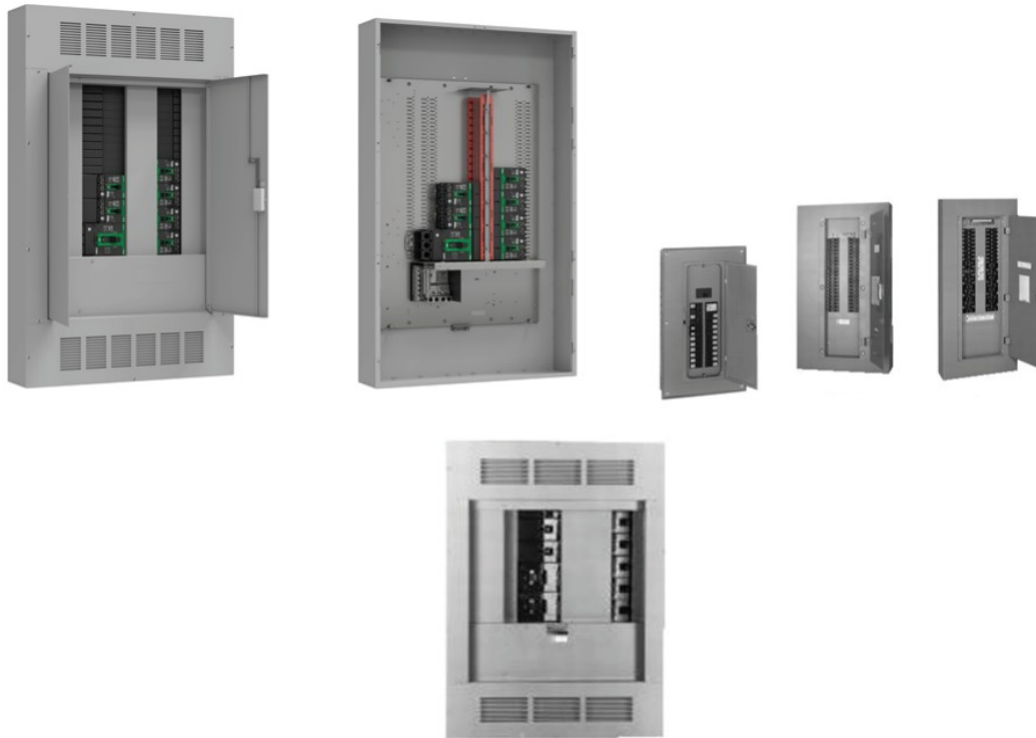
Prevention By Design: Arc Flash Mitigation Types	Protection During Operation	Protection During Maintenance / Abnormal Operation	Reduced Incident Energy(cal / cm ²)	Recovery Time	Impact on Footprint	Impact on Commissioning	Modifying Existing Equipment	CapEx	OpEx
Barriers / ANSI compartmentalization	Yes	Limited	No	N/A	None	Low	Application dependent	\$	\$
High resistance grounding	Limited	Limited	No	N/A	Low	High	Possible	\$\$	\$
Gas insulated switchgear	Yes	Limited	No	N/A	Improves	Medium	No		
Shielded solid insulated switchgear	Yes	Limited	No	N/A	Improves	Medium	No		
IR thermographic study	Increases exposure	Increases exposure	No	Predictive	None	None	N/A	\$	\$\$
Continuous thermal monitoring	Alert only	Alert only	No	Predictive	Low	Low	Possible	\$\$	\$
Continuous humidity monitoring	Alert only	Alert only	No	Predictive	None	Low	Easily	\$	

Table 28 - Incident Energy Reduction Methods

Prevention By Design: Arc Flash Mitigation Types	Protection During Operation	Protection During Maintenance / Abnormal Operation	Reduced Incident Energy (cal / cm ²)	Recovery Time	Impact on Footprint/ Commissioning	Impact on Commissioning	Modifying Existing Equipment	CapEx	OpEx
Energy reducing maintenance switch	Limited	Limited	Less than 8/12	Hours / days ¹²⁰ depending on ERMS switch been turned on	None /Low	Low	Possible	\$\$	\$
Circuit breaker with instantaneous or override below arcing level	Limited	Limited	Less than 8/12	Hours / days	None /Medium	Medium	Limited	\$\$	\$

119. A. C. Parsons, "Arc Flash Application Guide Arc Flash Energy Calculations for Circuit Breakers and Fuses", Square D/Schneider Electric Engineering Services, August 2004

Figure 96 - Panelboards



Panelboards are used to group the overcurrent protection devices for several circuits together into a single piece of equipment. In small installations they may serve as the service equipment. The NEC The National Electrical Code¹²⁴ divides panelboards into two categories:

Lighting and Appliance Branch-Circuit Panelboard: A panelboard having more than ten percent of its overcurrent devices protecting lighting and appliance branch circuits.

Power Panelboard: A panelboard having ten percent or fewer of its overcurrent devices protecting lighting and appliance branch circuits.

Separated Distribution Panelboard: A panelboard combining the above Lighting and Appliance Branch-Circuit and Power Panelboards.

Lighting and appliance branch-circuit panelboards are limited to a maximum of 42 overcurrent devices, excluding mains. UL 67 UL Standard for Safety for Panelboards, UL 67, Underwriters Laboratory, Inc.¹²⁵ designates Class CTL Panelboard as the marking for appliance and branch circuit panelboards; CTL stands for "circuit limiting". In some manufacturer's literature lighting and appliance branch-circuit panelboards for residential or light commercial use are referred to as load centers.

Panelboards are available with built-in main devices or as main lugs only (MLO). The NEC The National Electrical Code¹²⁴ requires appliance and branch circuit panelboards to be individually protected on the supply side by not more than two main circuit breakers or two sets of fuses having a combined rating no greater than the rating of the panelboard. Lighting and appliance branch circuit panelboards are not required to have individual protection if the feeder overcurrent device is no greater

Figure 97 - Switchboards



Switchboards are available with a main circuit breaker or fusible switch, or as main lugs only. The available ampacities and multi-section availability makes them more flexible than panelboards. They are generally available utilizing either copper or aluminum bussing, and with a variety of bus plating options. Custom bussing for retrofit applications is also possible.

Switchboard circuit breakers may be stationary-mounted (also referred to as fixed-mounted), where they can be removed only by unbolting of electrical connections and mounting supports, or drawout-mounted, where they can be removed without the necessity of removing connections or mounting supports. It is possible to insert and remove drawout devices with the main bus energized. The section that contains the main circuit breaker(s) or service disconnect devices is referred to as a main section. A section containing branch or feeder circuit breakers is referred to as a distribution section.

Devices mounted in the switchboard may be either panel mounted (also referred to as group mounted), where they are mounted on a common base or mounting surface, or individually mounted, where they do not share a common base or mounting surface. Individually mounted devices may or may not be in their own compartments. A device which is segregated from other devices by metal or insulating barriers and which is not readily accessible to personnel unless special means for access are used is referred to as an isolated device. Group and Individually-mounted Devices, page 168 shows examples of sections with group and individually-mounted devices.

The main through-bus is often referred to as the horizontal bus. The bussing in a section which connects to the through-bus is referred to as the section bus (also known as vertical bus). The bussing that connects the section bus to the overcurrent devices is referred to as the branch bus. Section and branch busses may be smaller

Figure 98 - Group and Individually-mounted Devices



Switchboards are available with several accessories, including custom-engineered options such as utility metering compartments, automatic transfer schemes, and modified-differential ground fault for switchboards with multiple mains. However, the internal barriering requirements are minimal.

Motor Control Centers

Table 31 - Low-voltage Motor Control Centers: Quick Reference

Available Voltage Ratings	120–600 V
Available Current Ratings	600–2500 A
Available Short-circuit Ratings	Through 100 kA
Major Industry Standards	NEMA ICS-18, UL 845, NEC
Typical Enclosure Types	1, 1A, 3R, 12
Primary NEC Requirements	Article 430

A motor control center (MCC) is defined as “a floor-mounted assembly of one or more enclosed vertical sections typically having a common power bus and typically containing combination motor control units” (see *UL Standard for Safety for Motor Control Centers*¹²⁹). Motor control centers are used to group several combination motor controllers together at a given location with a common power bus. MCCs are typically found in large commercial or industrial buildings where there are many electric motors that need to be controlled from a central location. *Low-Voltage Motor Control Center*, page 169 shows an example of a motor control center.

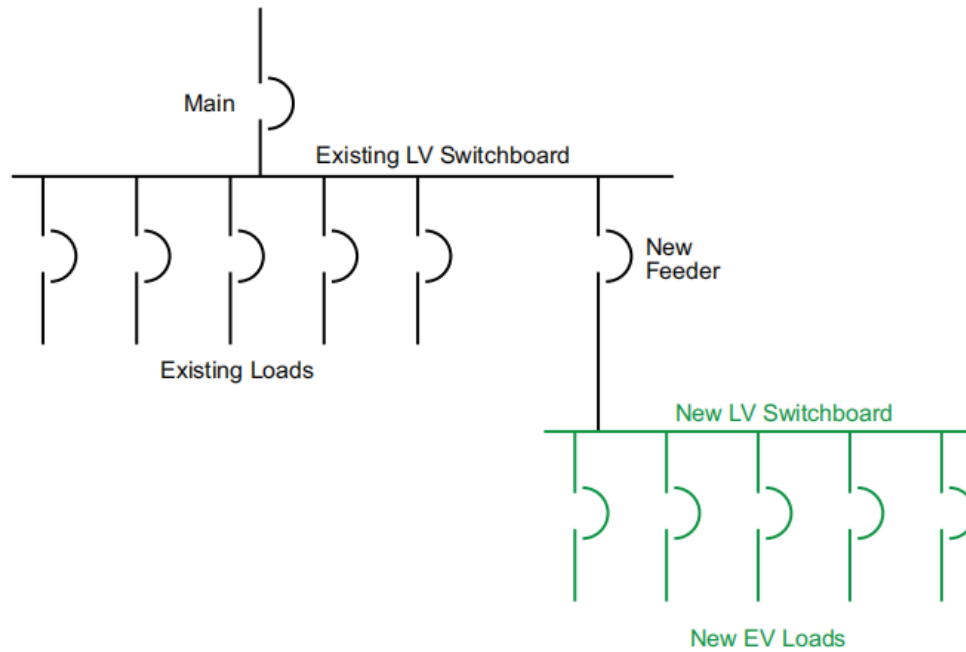
Low-voltage switchgear is typically built as “rear accessible” meaning the access to load cabling and connections are from the rear of the equipment. In situations where space is limited, low-voltage switchgear may be built as “front accessible” where the access load cabling and connections are from the front of the equipment. This allows the low-voltage switchgear lineup to be placed against a wall. This configuration is also useful in electrical house applications where no exterior doors are necessary to access the back side of the equipment.

Figure 100 - Low-voltage Switchgear



Low-voltage switchgear is compartmentalized to reduce the possibility of internal fault propagation. ANSI C37.20.1 (see *IEEE Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear*¹³⁴) requires each breaker to be provided with its own metal-enclosed compartment. Optional barriers are usually available to separate the main bus from the cable terminations, forming separate bus and cable compartments within a section, as well as side barriers to separate adjacent cable and bus compartments.

Figure 153 - EV Loads Integrated into the Existing Electrical Infrastructure



It is important to perform a power system study to ensure the power load can be added to the existing electrical infrastructure. Energy efficiency measures could be proposed to reduce the existing consumption and therefore increase the power

As specified in NEC Section 625, the power distribution equipment feeding the EVSE shall have sufficient rating to supply the load served. Overcurrent protection for feeders and branch circuits supplying electric vehicle supply equipment shall be sized for continuous duty and shall have a rating of not less than 125 percent of the maximum load of the electric vehicle supply equipment. Electric vehicle charging loads shall be considered continuous loads unless an automatic load management system is used, in which case the maximum equipment load on a service and feeder shall be the maximum load permitted by the automatic load management system. This section assumes that an automatic load management system is not present. More information about automatic load management systems and smart charging may be found in the Charge Management Software section.

Municipal guidelines should be consulted for new construction projects involving parking to determine the minimum number of spaces that need EVSE. Some utilities offer special rates for EV charging installations. To be eligible for the EV tariff, utility requirements may specify a dedicated meter for the EV chargers.

Remembering charger types:

- AC Level 2 chargers are typically rated for installation in 208/120 V systems or 240 V systems. Most require a 2P breaker as OCPD.
- DCFC will typically be fed from a 480 V 3P breaker.

For example, consider a site with (10) Level 2 chargers rated 7.2 kW / 30 A. For each breaker rating, find 125% of the EVSE's current rating:

$$30 \text{ A} * 1.25 = 37.5 \text{ A}$$

The OCPD for each of the chargers will be the next highest available standard size: 40 A.

A 208/120 V panelboard to feed these (10) chargers may have a panel schedule like this:

CKT #	Load Desc.	Trip	Pole	A		B		C		Pole	Trip	Load Desc.	CKT #
				L BUS	R BUS	L BUS	R BUS	L BUS	R BUS				
1	7.2 kW Charger	40 A	2	3120	3120					2	40 A	7.2 kW Charger	2
3						3120	3120						
5	7.2 kW Charger	40 A	2					3120	3120	2	40 A	7.2 kW Charger	2
7				3120	3120								
9	7.2 kW Charger	40 A	2			3120	3120			2	40 A	7.2 kW Charger	2
11								3120	3120				
13	7.2 kW Charger	40 A	2	3120	3120					2	40 A	7.2 kW Charger	2
15						3120	3120						
17	7.2 kW Charger	40 A	2							2	40 A	7.2 kW Charger	2
19				3120	3120								
21													
23													
25													
27													
29													
Total Load (VA):				24960		18720		18720					

The total connected load is 62400 VA, or 173.2 A. The next highest main breaker size would be 200 A.



**Schneider Electric
NQ Panelboard**

Schneider Electric NQ Panelboards have 400 A and 600 A options with main circuit breakers. These panels can be applied at 208 V or 240 V, either alone or in an IPC2 unit. If more Level 2 chargers are required, they may be fed from additional panels.

The following quantities use a continuous current rating for the EVSE loads (no LMS)

Charger	NQ 208 V 400 A	NQ 208 V 600 A	NQ 240 V 400 A	NQ 240 V 600 A
	Quantity	Quantity	Quantity	Quantity
7.2 kW L2	18	26	16	24
7.6 kW L2	17	25	15	22
9.6 kW L2	13	20	12	18
11.5 kW L2	11	17	10	15
19.2 kW L2	6	10	6	9

NOTE: 70 A to 100 A 2P breakers are limited to 11 breakers per panel due to the neutral connection limitations.



IPC2 "EV Pod"

Available Voltage (utility xfmr sec or point in system where to tap off for EVSE addition)	Type of EVSE Needed	Recommended Equipment
480 V	DCFC Chargers	Switchboard with breakers to DCFC OR Switchboard to I-Line panels to DCFC
480 V	AC L2 Chargers	480 V switchboard to step-down transformer to panel(s) to L2 EVSE OR 480 V switchboard to IPC2 "EV Pod" integrated step-down transformer and panels to L2 EVSE
480 V	Mix of DCFC and L2 Chargers	IPC2 "EV Pod" with a 480 V panelboard, step- down transformer, and 240 V or 208 V panelboard
208/120 V	DCFC Chargers	Step-up transformer to 480 V I-Line panelboard or QED2 switchboard
208/120 V	AC L2 Chargers	NQ Panelboard
208/120 V	Mix of DCFC and L2 Chargers	IPC2 "EV Pod" with a 208/120 V panelboard, step-up transformer, and 480 V panelboard

Figure 154 - IPC2 "EV Pod" elevation with 480 V, 800 A I-Line panelboard, step-down transformer, and 208 V, 600 A NQ panelboard

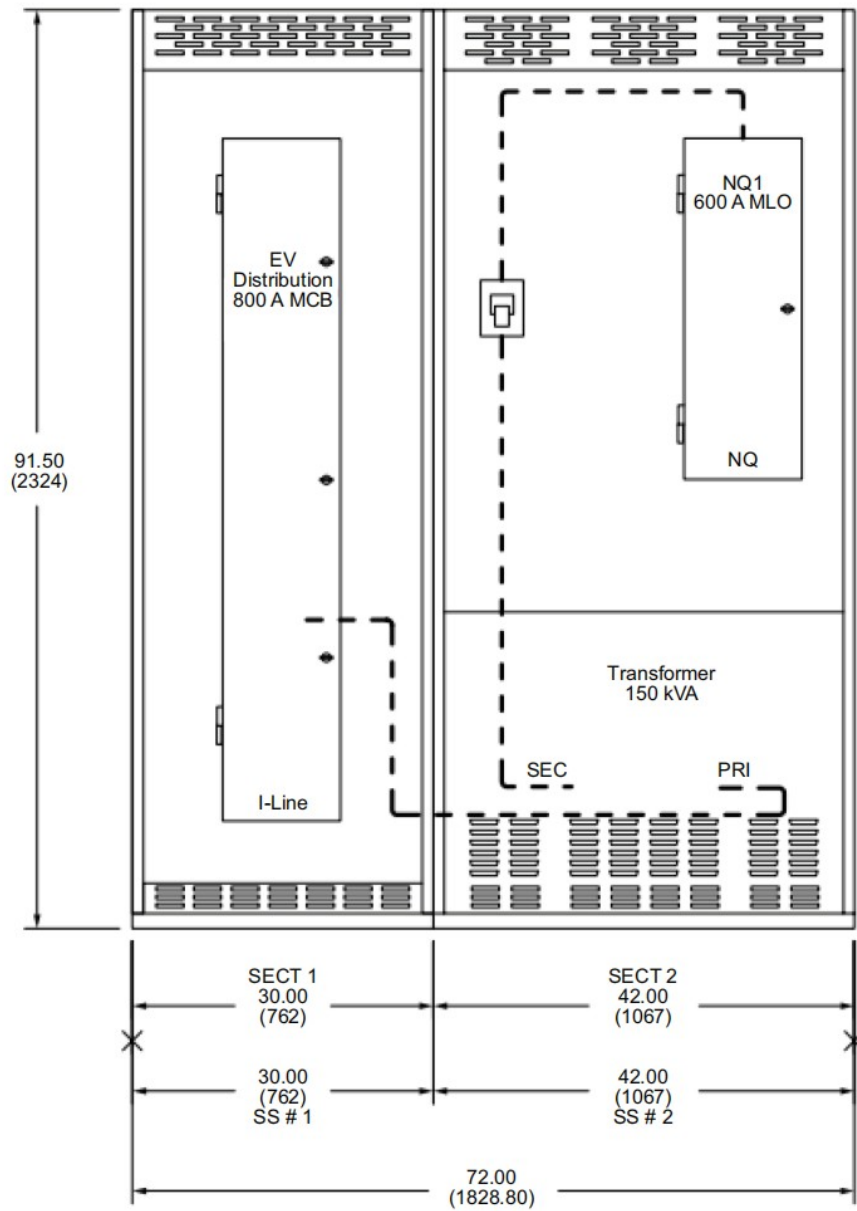
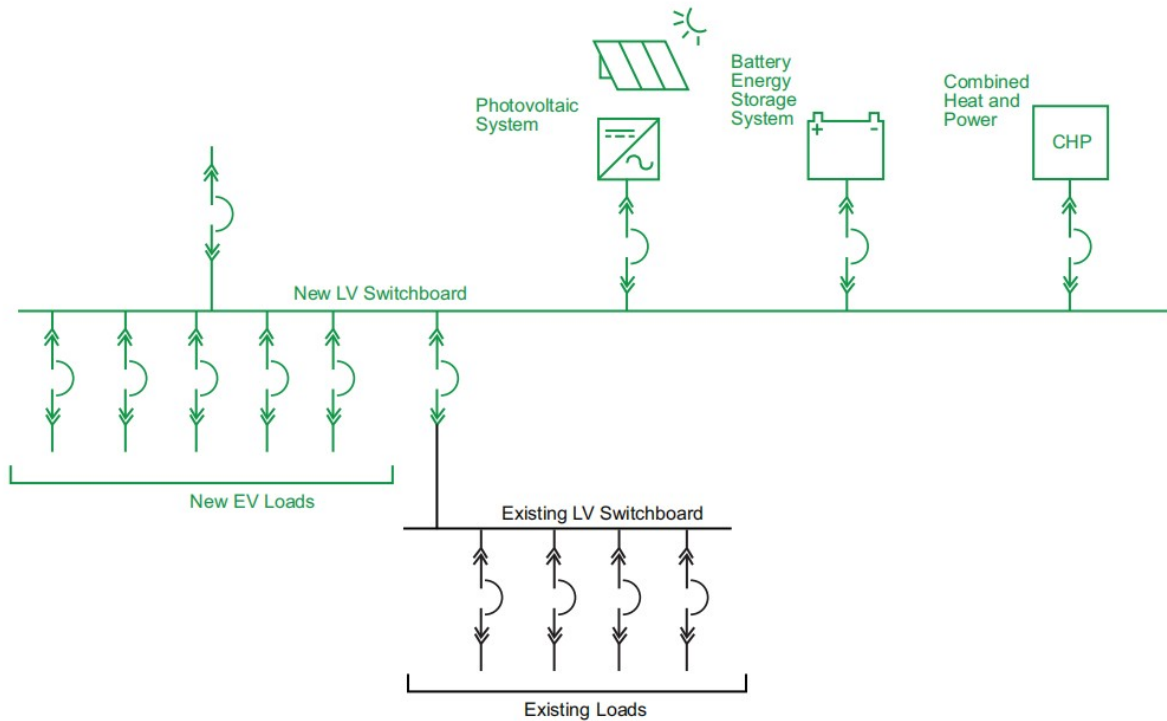


Figure 156 - EV Loads and Local Power Supplies Integrated into a New Main Low Voltage Switchboard



Busduct

Example solution for a parking structure.

I-Line Busway

800–5000 A busway

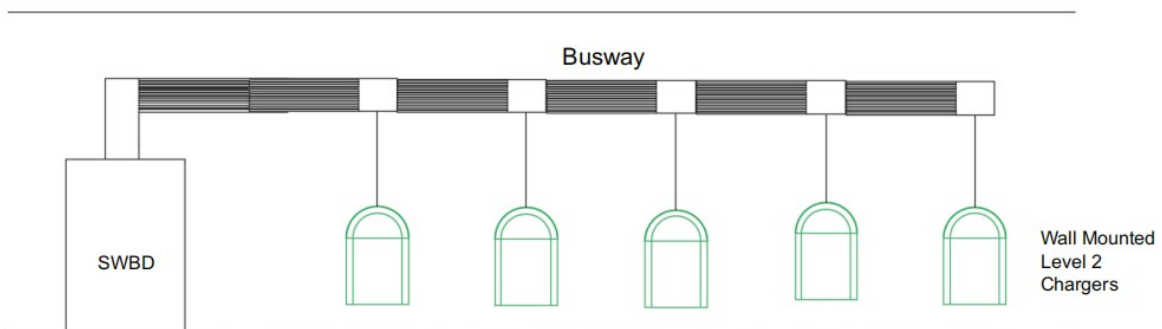
Aluminum and/or Copper

Plug-in or bolt-on disconnects

30 A, 60 A, 100 A, 200 A, 400 A, 600 A + plug-in circuit breaker disconnects

Fusible or circuit breaker plug-in units

Circuit breakers with electronic trip unit (ETU), communications (Ethernet or Modbus)



Charge Management Software

Charge Management Software (CMS) communicates directly with the EV chargers for monitoring and control. Automatic load management systems can alleviate the impact of EV installations by setting a maximum power limit for a group of EVSE. This software is also how equipment owners can bill for charger usage and drive ROI on their EVSE investment.

Key terms:

- **Smart chargers** are internet enabled hardware units that work with software management to provide the best driver and owner experience. Smart chargers are also required hardware when applying for incentives.
- **Software management** enables you and your clients to have complete control of your charging program, reduce costs, capture incentives, and ensure a positive ROI and driver experience.
- **Load Management Software** balances the existing output capability among the energy-consuming assets in a building or business. Linked directly to a site's electrical capacity. Works with smart charging and demand response.
- **Demand Response** is implemented at the power company level.

As illustrated in the following, there are different communication protocols between the electric vehicle (EV) and the electric vehicle supply equipment (EVSE), and between the EVSE and the CMS.



ISO 15118 is a set of protocols that allow EVs to communicate with charging stations. ISO 15118-2 pertains to network and application protocol requirements for communication between electric vehicles and charging stations.

- **Plug & Charge** – A standardized, secure authentication process where an EV automatically identifies itself to the charging station, initiating and authorizing charging without requiring user interaction (such as RFID cards or apps).
- **AutoCharge** – A simpler method for automatic charging session initiation based on the vehicle's MAC address. AutoCharge starts charging when the vehicle is recognized by the charging station.

Feature	Plug and Charge	AutoCharge for Level 2
Communication	ISO 15118-2	ISO 15118-2
Standard	ISO 15118	Proprietary (no universal standard)
Security	High (uses encrypted certificates)	Moderate
Setup	Complex (requires EV, charger, and CPO support)	Simple (requires MAC address registration)
Vehicle Requirement	ISO 15118 compliant vehicles	ISO 15118 compliant vehicles
Primary Use Case	Public charging, fleets	Commercial fleets

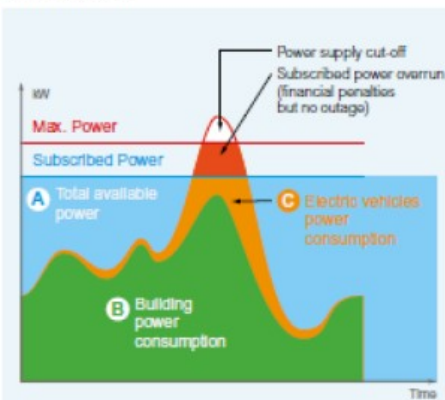
Open Charge Point Protocol (OCPP) is an open communication protocol that allows EV charging stations to communicate with central management systems. There are several versions currently available and in development.

of the power. When driver 2 plugs in, both cars will get 66%. When driver 3 plugs in, all three get 33%, and so on for each circuit. Ideal for scenarios where drivers are parked for long duration, you can see how this has a positive impact on your client's infrastructure costs and charging capacity.

These systems are remarkably simple to use, too. You select peak power or energy usage and tell the system how to judge that amount: either by the total amount consumed or amount used over a specific period of time or make the amount responsive to grid demand. You then set power-sharing settings, picking certain amounts for each vehicle, or using a first-in, first-out system.

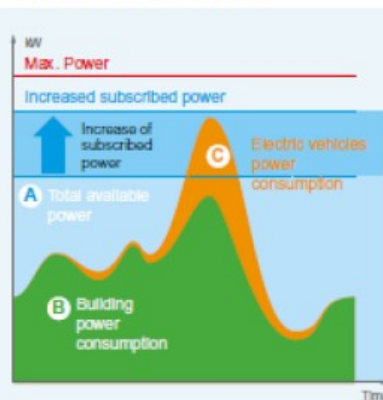
Here's how load management uses software to maximize the site's current infrastructure:

The problem Initial situation



The installation of charging stations in an existing electrical installation can have a significant impact due to the power level required by electric vehicles to charge.

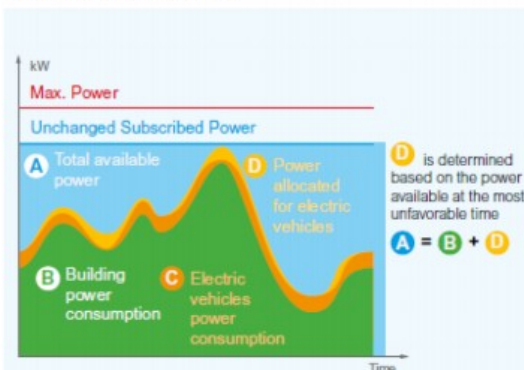
Solution without energy management Increase of subscribed power



This solution consists of increasing the power subscribed to the energy supplier to maintain the same consumption model. It implies an increase in the cost of the subscription and does not guarantee that the trigger threshold will never be exceeded. Thus the continuity of service of the building is not guaranteed.

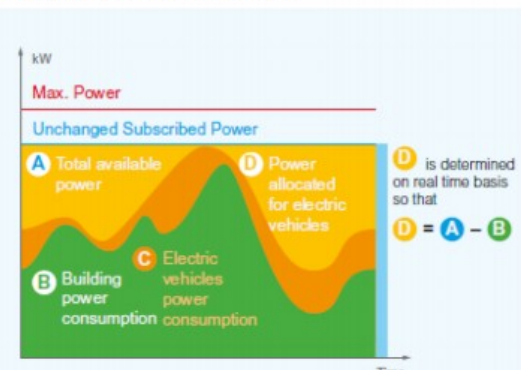
If such solution is not installed, the installation should be sized for the maximum power demand without considering charging period and usage coefficient. As consequence, the installation will be oversized versus the real need, and the costs of the EV charging infrastructure will be higher.

Determination of dynamic setpoint STATIC loads management



Setpoint "D" is fixed. The power is distributed between all connected vehicles.

DYNAMIC loads management



Setpoint "D" is adjusted in real time according to the consumption of the rest of loads in the building, to maximize the power allocated to charging electric vehicles.

Schneider Learning Series – ASCO Offer

Understanding Technical Documents and Design Resources

25th August 2020

ASCO Power
Technologies™

Course Code: CEU 331
CEU Value: 0.1 CEU

Learning Objectives

1

Identifying useful resources from the design perspective and how do these differ than resources used from the project channel.

2

Understanding how the project is structured to best apply your research and knowledge

3

Listing best practices to articulate your design intent on the document you're providing

4

Post document release, addressing Conflicts in the Documentation

5

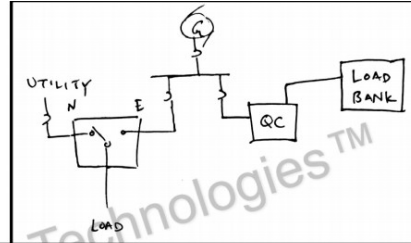
Quick Basic overview of Transfer Switch types

Sources of Information

- Identifying useful resources from the design perspective and how do these differ than resources used from the project channel (i.e. owner)
 - Codes and AHJs
 - Manufacturer white papers
 - Manufacturer sales reps/engineers
 - Manufacturer presentations
 - Your own experiences
- What/Who is driving the design?
 - Owner requested project
 - Owner problem they are looking to solve
 - Code required
- How do we interpret this information?
 - Per plans and specs?
 - Per budget constraints?

Project Structure

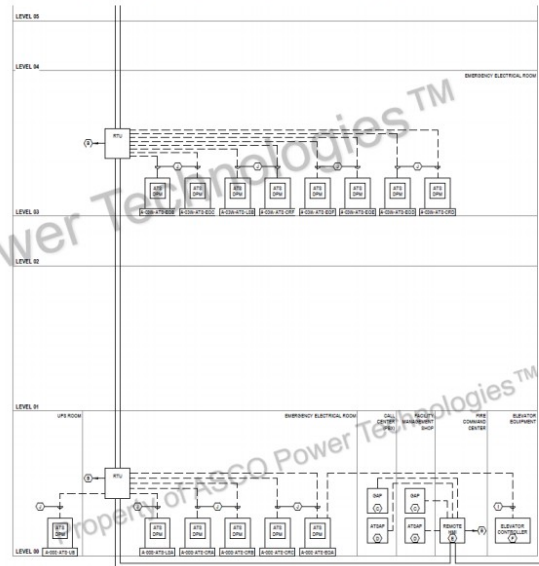
- What are the pieces of a project?
 - Idea
 - Sketch
 - "Hey, I want something to do this..."
 - Generally little to no information
 - Requires a lot of follow up questions
 - Size? Voltage?
 - 3 pole / 4 pole?
 - What is the load on the ATS?
 - How big is the generator?
 - Want this as Service Entrance?
 - What size is the Load Bank?
 - Narrative
 - Typically short and descriptive paragraph outlining overall project description
 - "Macro" look at the project
 - May or may not be accompanied by one-line



- C. The new 500 kW generator shall feed into a new 2500 Amp Paralleling, service entrance rated, switchboard (with draw out breakers) to be paralleled with the existing 800kW Onan/Cummins generator at the existing site. The switchboard shall be fully capable of integrating the two generators seamlessly.
1. Paralleling switchboard shall be fed from a new 480 Volt power company service.
 2. Provide a new 2500 Amp, 480 Volt, switchboard on the output of the paralleling switchgear. Provide the following breakers and panels:
 - a) 500/3P to feed a new 500 Amp, 480 Volt Panel to feed the input and bypass breakers for the UPS's
 - b) 600/3P to feed a new 600 Amp, 480 Volt panel to feed the CRAC units.
 - c) 2) 400/3P to feed the new chillers.

Common Types of Drawings – Elevation or Riser

- Shows equipment by building level
- In this example:
 - ATS designation and quantity on Levels 00 and 03
 - ATS Room Locations
 - Communication interface between equipment
 - Tag notes can help add more details to the bidders that would be otherwise difficult to articulate in drawing format

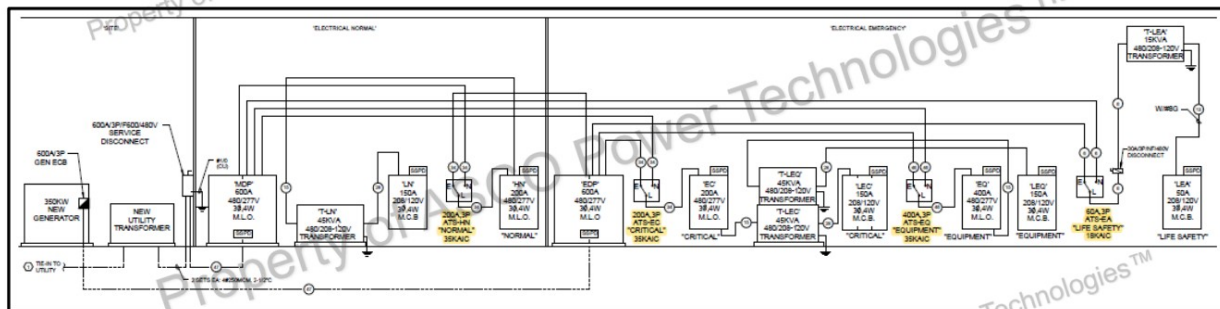


Common Types of Drawings – One Line Diagrams

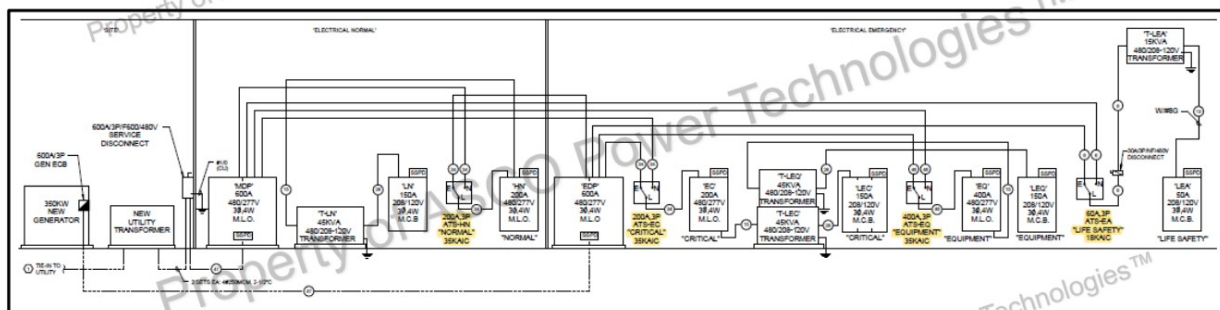
■ One Line Diagrams – What symbols are we looking for?

- Incoming Transformers – Utility Feeds
- Generator(s)
- Transfer Switch(es)
- Paralleling Switchgear
- Surge Devices
- Roll Up Generator Connection Points
- Interlock Connections
- External Control Wiring Connections
- Keyed Notes

Common Types of Drawings – One Line Diagrams



Common Types of Drawings – One Line Diagrams

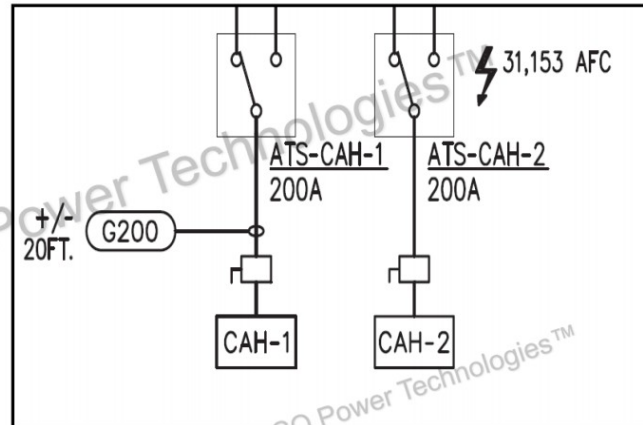


Common Types of Drawings – One Line Diagrams

■ Key notes & drawing symbols

● Detail

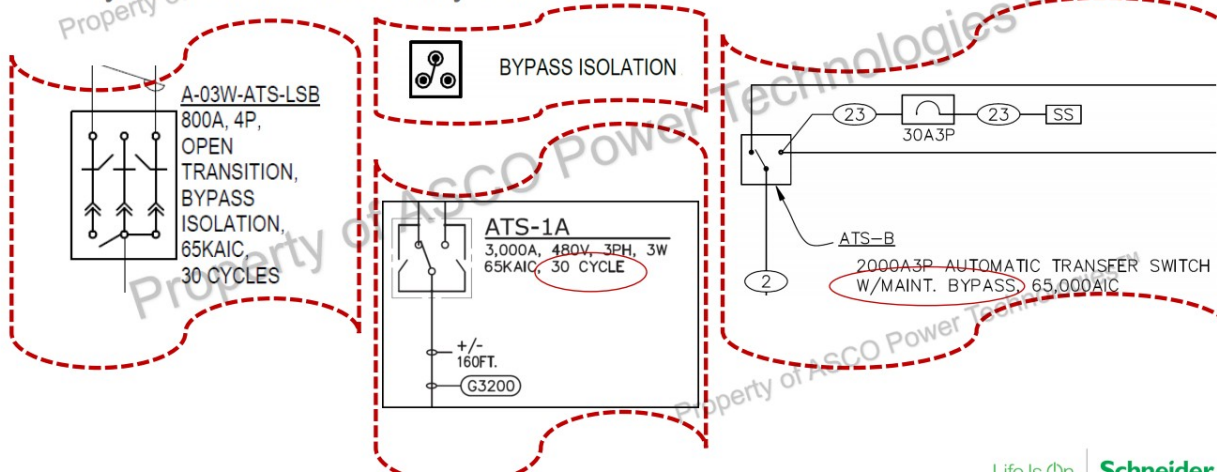
- Feeder Counts & Lug Sizes
 - Additional Symbol more lug info
- Operation
 - Best way to transfer power with large motor loads
- Withstand and Close-On Ratings
 - What size switch do I need for WCR of 31kA



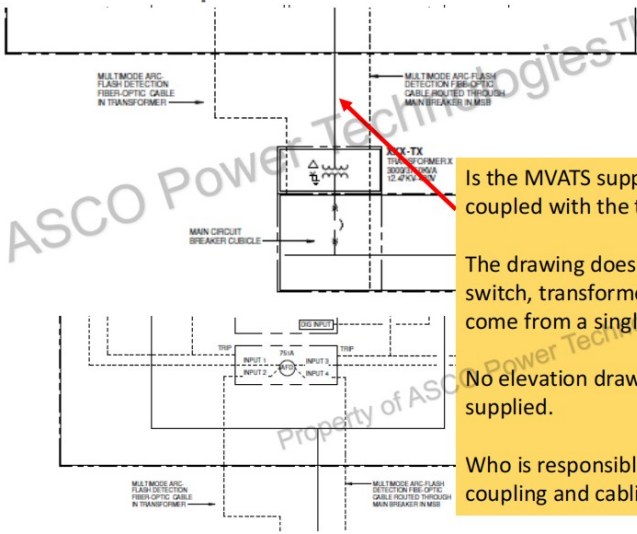
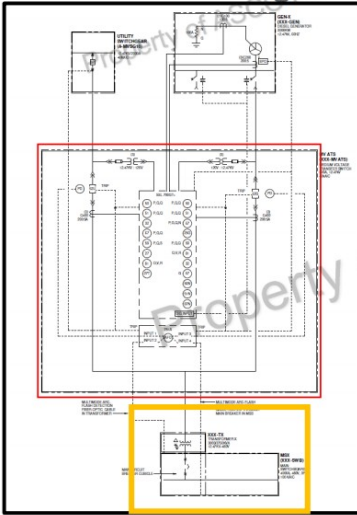
Common Types of Drawings – One Line Diagrams

■ Deciphering the key

- Symbols aren't necessarily consistent



One Line Diagrams – More Examples



Is the MVATS supposed to be close coupled with the transformer?

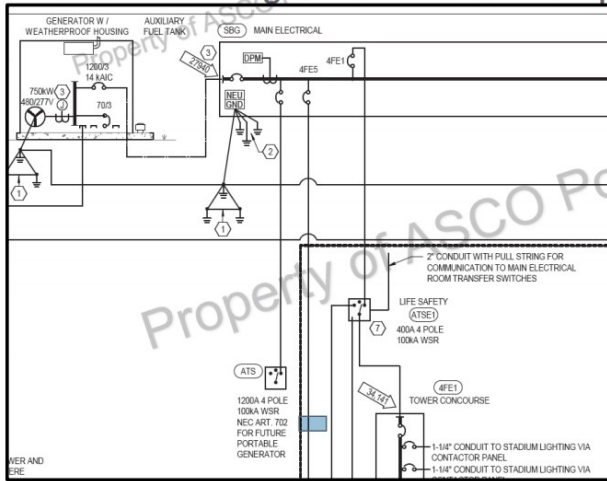
The drawing doesn't specify if the switch, transformer and distribution come from a single manufacturer.

No elevation drawings were supplied.

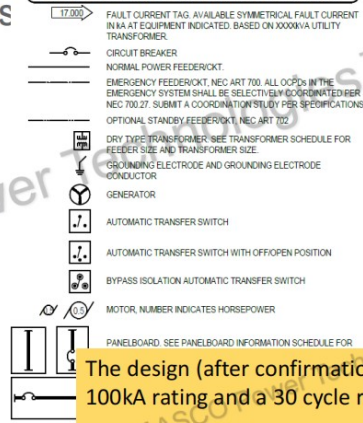
Who is responsible for close coupling and cabling?

Project Structure

One Line Diagrams – More Examples



SINGLE LINE DIAGRAM LEGEND



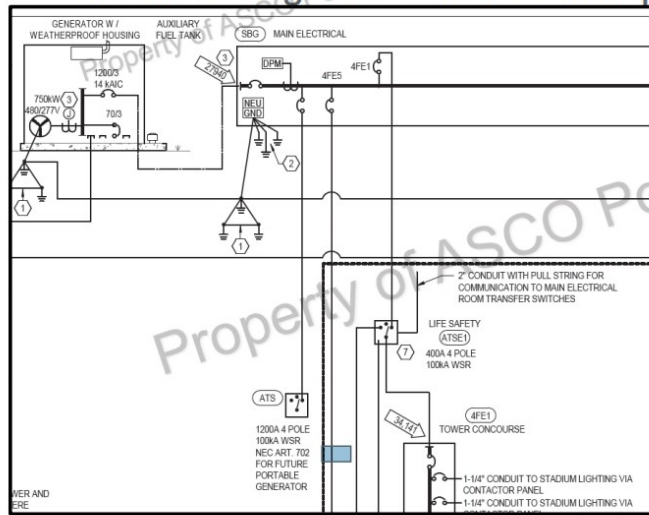
Bill of Material

- 4 pole, 480v
- Delayed Transition
- WCR
- 3 cycle
- 18 cycle
- 30 cycle
- Non Bypass

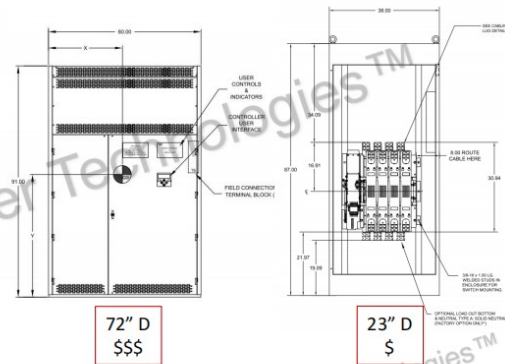
The design (after confirmation) was 100kA rating and a 30 cycle rating.

The WCR changed back to 3 cycle after the coordination study was completed.

■ One Line Diagrams – More Examples



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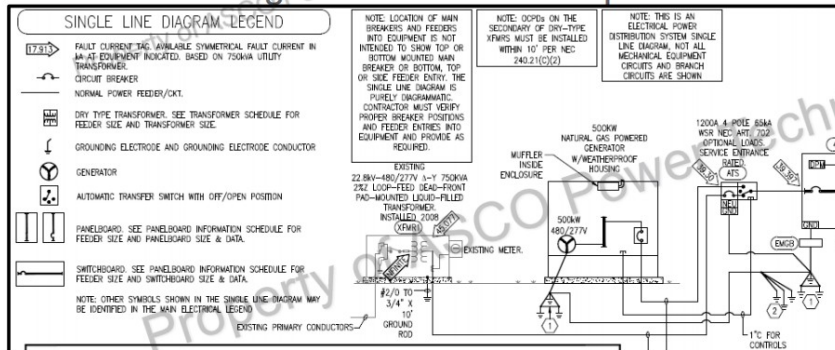
The design (after confirmation) was 100kA rating and a 30 cycle rating.

The WCR changed back to 3 cycle after the coordination study was completed.

Life Is On 

Project Structure

■ One Line Diagrams – More Examples



Bill of Material

- 1200A, 4 pole, 480v
- Delayed Transition
- Service Entrance Rated
- Bypass Isolation

There's a clear definition for indicating the switch is bypass within the specification and the drawing symbols.

SER – Indicated on dwg
Voltage/Current - Indicated on dwg
Bypass – NOT Indicated on dwg

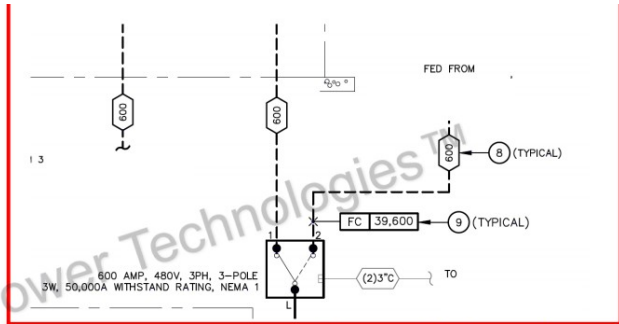
Specification Notes: 2.1.1 By-Pass/Isolation Switches

Include by-pass/isolation switches for the indicated automatic transfer switches. Provide by-pass/isolation switches in accordance with UL 1008 that can be used to manually select an available power source to feed load circuits and to permit total isolation of the automatic transfer switch.

Project Structure

■ One Line Diagrams

- Key notes & drawing symbols
 - Details that maybe hidden in plain sight
 - Feeder Counts
 - Lug Types & Quantity



Straight forward:

- 600A, 480V
- 3 pole
- 50kA WCR
- NEMA 1 Enclosed
- Refers to cable schedule

Not as straight forward:

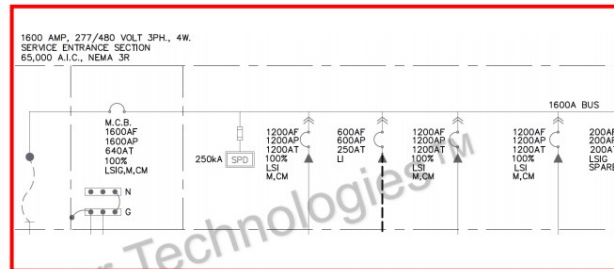
- Type of lug connections



Project Structure

■ One Line Diagrams

- Key notes & drawing symbols
 - Details that maybe hidden in plain sight
 - Types of Breakers Required

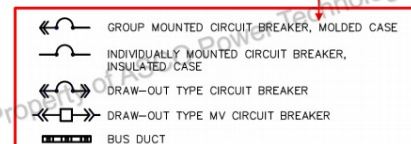


Straight forward:

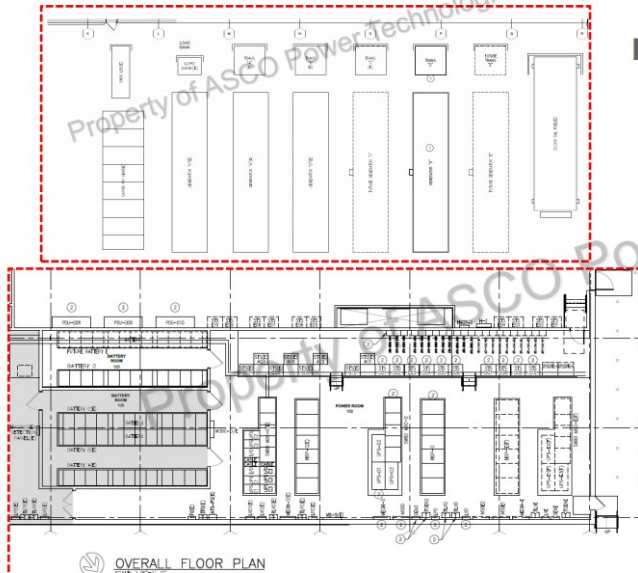
- Size and ratings of the breakers
- Voltage
- Board Interrupt Rating

Not as straight forward:

- Types of breakers required

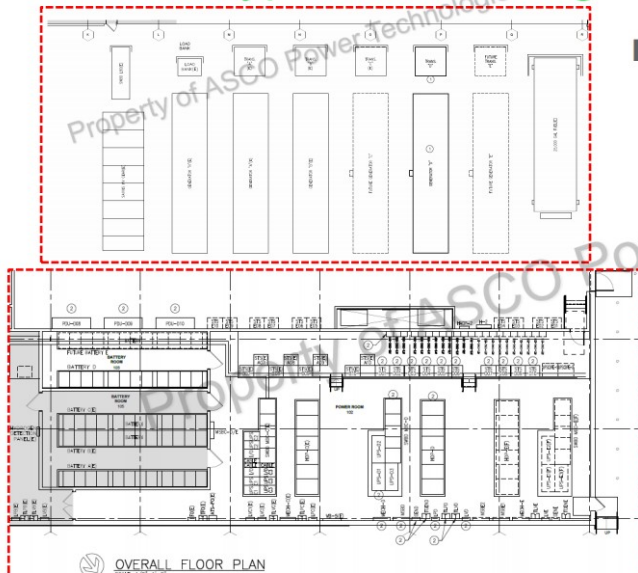


Common Types of Drawings – Floor Plan



- Physical position of the equipment
 - Based on footprint equipment size and clearances
 - Entry and Exit positions
 - Estimated or exact room layout

Common Types of Drawings – Floor Plan



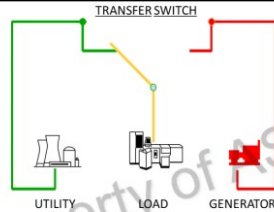
- Physical position of the equipment
 - Based on footprint equipment size and clearances
 - Entry and Exit positions
 - Estimated or exact room layout

Project Structure

■ MasterSpec

UL 1008 – Standard for Automatic Transfer Switches

Comply with UL 1008 unless requirements of these Specifications are stricter.



• Seven Major Functions of An Automatic Transfer Switch

- Carry Current Continuously
- Detect Power Failures
- Initiate Alternate Source
- Transfer Load
- Sense Restoration of Normal
- Retransfer Load To Normal

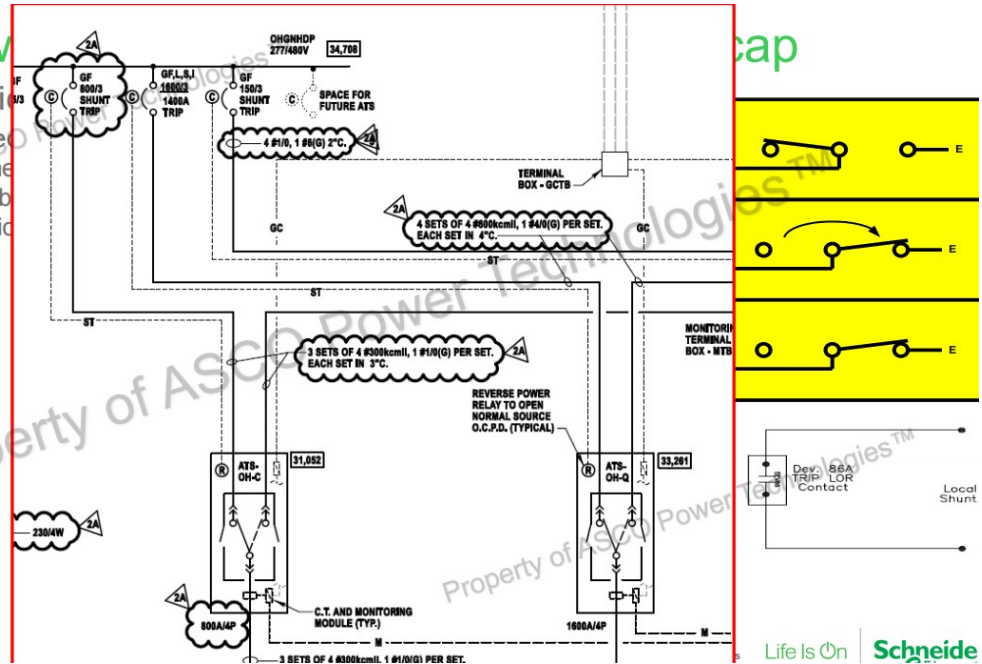
UL1008 Minimum Passing Criteria

- Overload Testing, 6x Rating
- Endurance, 6000 operations at 100% Rating
- Dielectric & Post Overload Temp. Rise
- Withstand & Close on Test
- Must be Operable by Intended Means
- Alternate Contacts Must Exhibit Continuity After Test
- Cabinet Must Remain Closed, No Breakage of Base.
- Conductors Can Not Pull Out of Terminals
- For Short Time Test: ALL Contacts Must Exhibit Continuity A Pass Temperature Rise!
- Must be "Like New"

Transfer Sw

"Closed" Transiti

- Utilities may require connection of both parallel condition



POST DOCUMENT RELEASE

Addressing Conflicts in the Documentation

RFIs, Addendums, Bulletins, Change Orders

■ RFIs, Requests For Information.

- Best practice is for the contractor and bidders to submit RFIs during the bid process, but this cannot always happen. Sometimes information isn't found out until a contractor starts work. As a design engineer or owner you may receive RFI's during a project to answer. Your answers should help direct the contractor and/or manufacturer how to proceed. Answers to RFI's at project award may lead to Change Orders.

■ Addendums

- Changes to the drawings following the 100% bid and permit / construction documents, but PRIOR to a project award. These changes are often highlighted or bubbled changes that can/may and quite often affect the cost of the affected equipment.

■ Bulletins

- Post award changes. Sometimes prompted by owner changes or field RFIs. Quite often accompanied with a Change Order.

■ Change Orders

- Cost changes to a project that fall out of the originally bid documents and/or contractual obligations of the contractors and/or manufacturers.

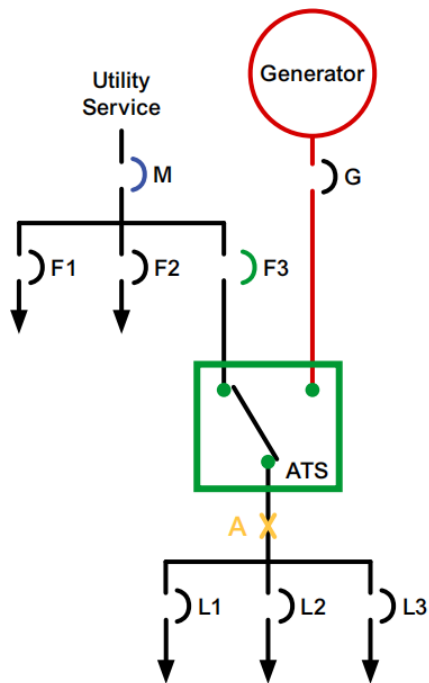


Figure 2: A fault at Point A should be cleared by Circuit Breaker F3, and not by Breaker M.

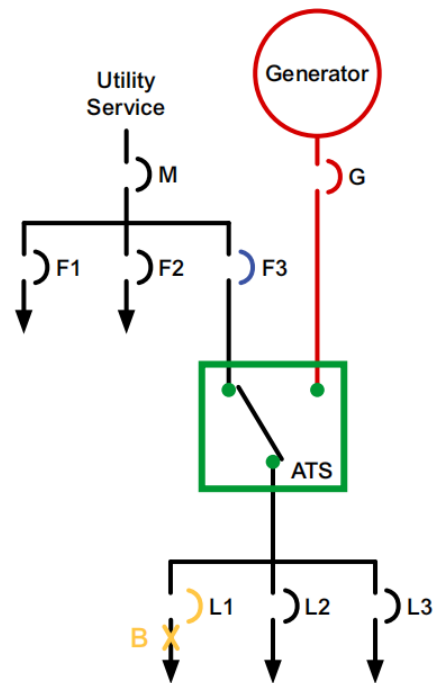


Figure 3: A fault at Point B should be cleared by Circuit Breaker L1, and not by Breaker F3 or the ATS.

To ensure that faults will be cleared by the breaker closest to a fault location, trip settings must be assigned to breakers following the completion of a coordination study of the power distribution system. This study should identify the amount of fault current that will be available at each OPD and transfer switch location so that appropriate time delays can be applied to upstream and downstream OPDs. The practice of applying sequential trip delays to OPDs to limit impact of outages is known as *selective coordination*. For more information about this practice, review our document entitled [Selective Coordination Basics](#).

After short-circuit current testing, a transfer switch must remain in a condition to connect loads to sources. The UL1008 standard prescribes criteria for post-test condition of the switch.

Closing on Faults

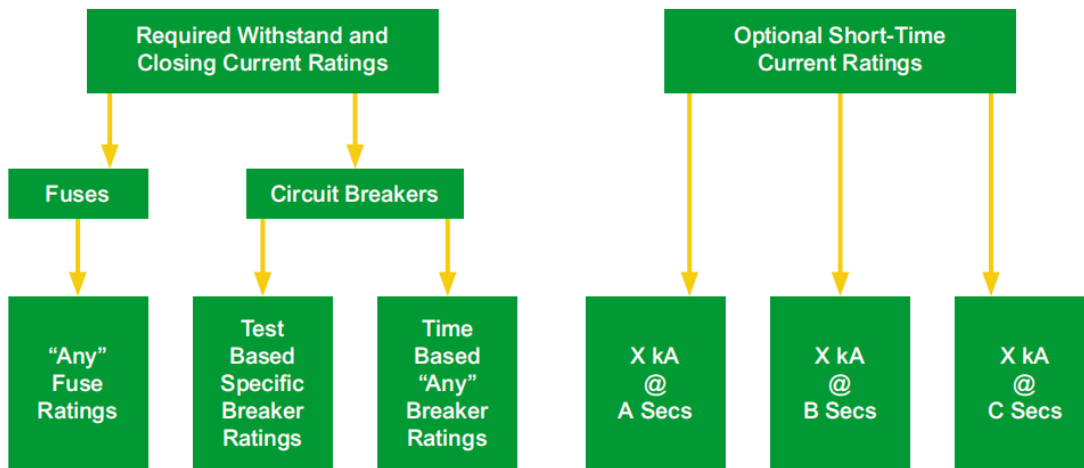
Transfer mechanisms must not only withstand faults but close on them as well. A primary reason is that a switch may be retransferred to a live power source while a fault is still present. The switch must be able to close on foreseeable faults so that, again, OCP devices can properly clear them. If the transfer switch cannot close, all the downstream loads will remain without power instead of the loads on only the faulted circuit.



Figure 4. UL1008 Withstand Test

UL1008 Rating Hierarchy

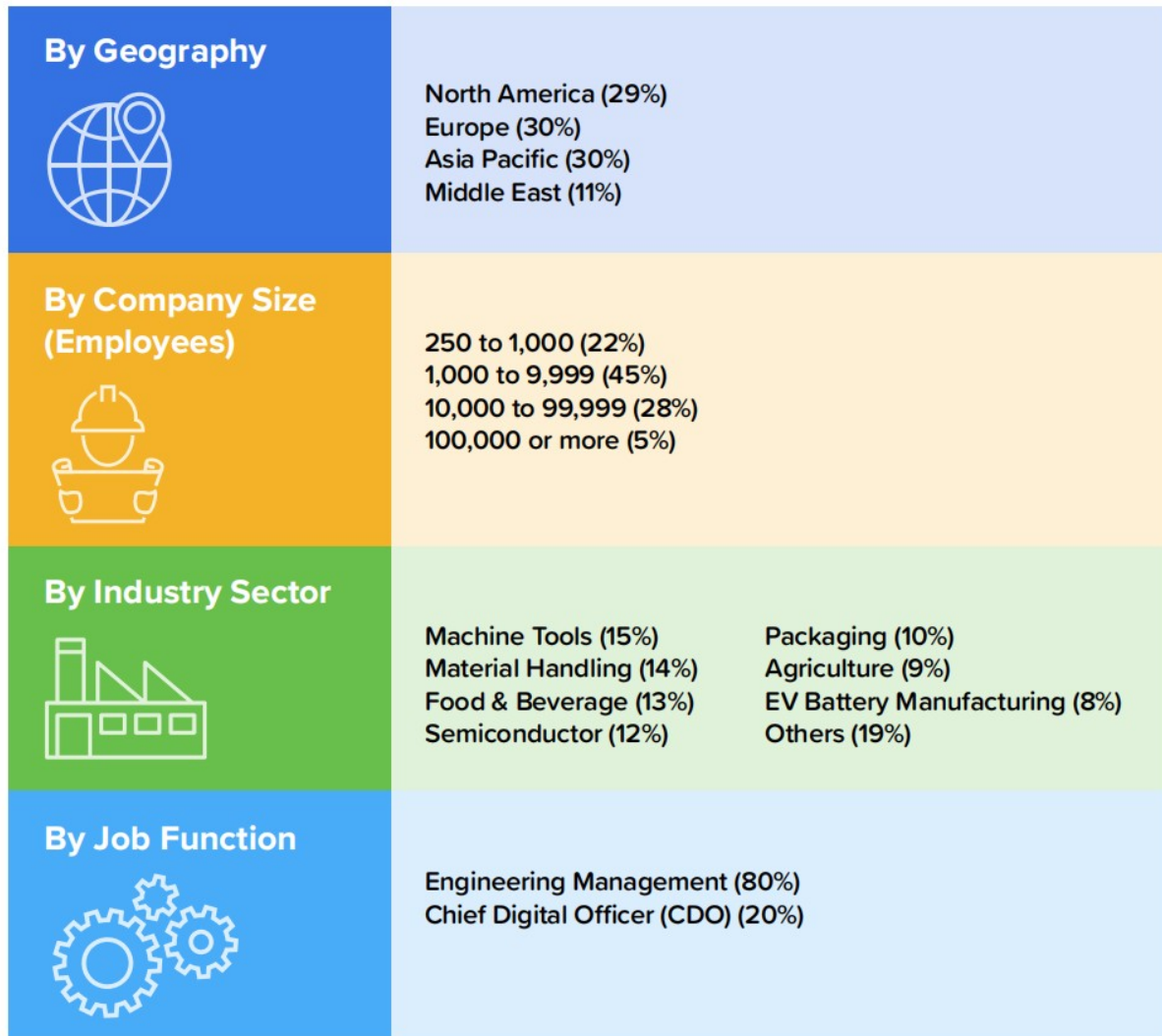
Based on the results of tests summarized herein, UL1008 enables manufacturer to offer Withstand and Closing Ratings according to the scheme in Figure 4. These include ratings for ATS served by: (1) fuses, (2) non-specific breakers, and (3) specific breakers that have been tested with the switch according to UL1008 procedures. In addition, manufacturers can test ATS to demonstrate short time ratings for one or more durations. As a practical example, the corresponding ratings for ASCO transfer switches, effective May 2019, are shown in Table 2.



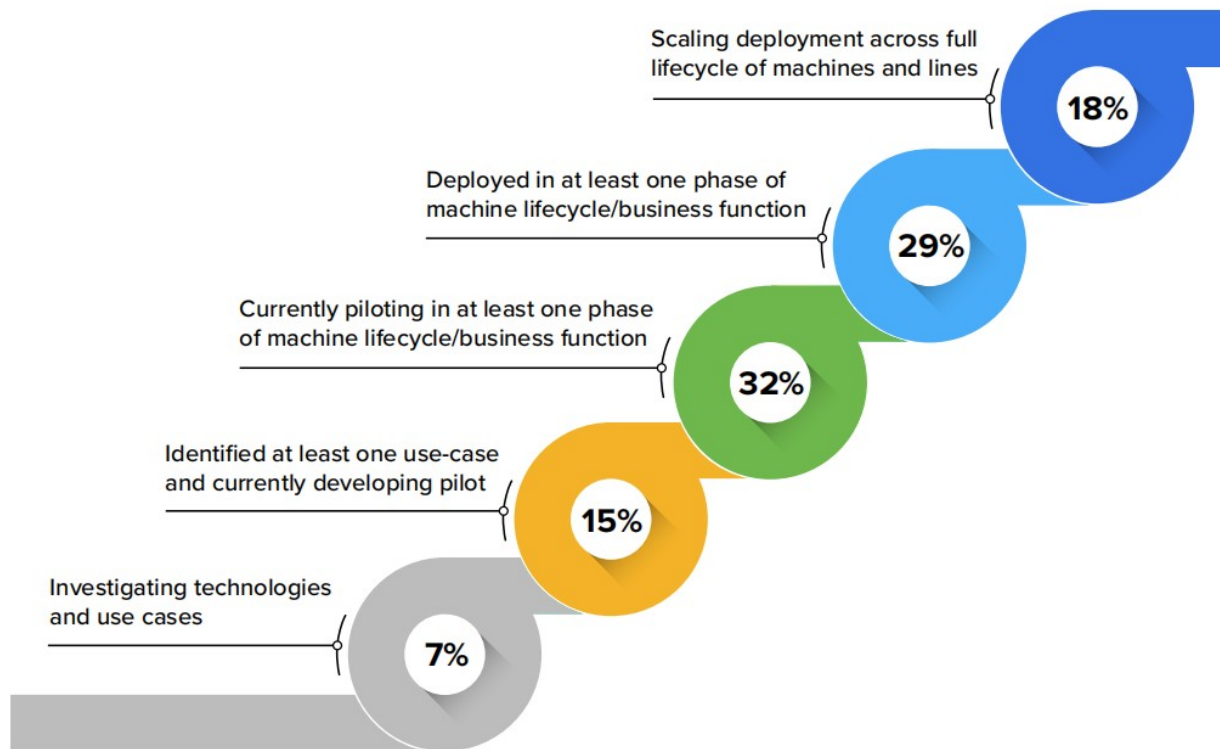
			300, 4000 & 7000 Series							4000 & 7000 Series				7000 Series								
Frame	Switch rating (Amps)		Current Limiting Fuses				Specific Breaker			Time Based				Short Time Ratings ³ (sec)								
														480V Max.				600V Max.				
	Transfer Switches	Bypass Switches	480V Max.	600V Max.	Max Size, A	Class	240V Max.	480V Max.	600V Max.	Time (sec)	240V Max.	480V Max.	600V Max.	.13	.2	.3	.5	.1	.13	.3	.5	
D	30	-	100kA	-	300	J	22kA	22kA	10kA	0.025	10kA	10kA	10kA	-				-				
			200kA	35kA	200	J																
			35kA	35kA	200	RK1																
D	70, 100	-	35kA	35kA	200	RK1	150kA	85kA	25kA	0.025	10kA	10kA	10kA	-				-				
			200kA	35kA	200	J																
D	150	-	35kA	35kA	200	RK1	150kA	85kA	25kA	0.025	10kA	10kA	10kA	-				-				
			200kA	35kA	200	J																
D	200	-	200kA	35kA	200	J	200kA	85kA	14kA	0.025	10kA	10kA	10kA	-				-				
			35kA	35kA	200	RK1																
D	230	-	100kA	-	300	J	200kA	85kA	14kA	0.025	10kA	10kA	-	-				-				
E	260, 400	-	200kA	-	600	J	65kA	42kA	22kA	0.05	35kA	35kA	22kA	-				-				
J	150, 200, 260	150, 200, 230, 260	200kA	200kA	600	J	200kA	200kA	42kA	0.05	65kA	42kA ⁸	35kA	7.5kA	-		-					
J	400	400	200kA	200kA	800	L	65kA	50kA	42kA	0.05	65kA	42kA ⁸	35kA	7.5kA	-							
					600	J																
J	600	600	200kA	200kA	800	L	65kA	85kA	42kA	0.05	65kA	42kA ⁸	35kA	7.5kA ⁹	-							
			200kA	200kA	600	J																
H ⁶	600	600	200kA	200kA	1600	L	65kA	150kA	65kA	0.05	50kA	50kA	50kA	36kA	-				36kA	-		
P ⁸	600	600	200kA	200kA	1600	L	65kA	150kA	65kA	0.05	50kA	50kA	50kA	36kA	30kA		36kA	-				
P ⁸	800	800 - 1200	200kA	200kA	1600	L	65kA	150kA	65kA	0.05	50kA	50kA	50kA	36kA	30kA		36kA	-				
H	800 - 1200	800 - 1200	200kA	200kA	1600 ⁶	L	65kA	150kA	65kA	0.05	50kA	50kA	50kA	36kA	-		36kA	-				
Q ⁸	600 - 1600	600 - 1600	200kA	200kA	2000	L	65kA	65kA	65kA	0.05	65kA	65kA	65kA	50kA				50kA				
S ⁸	800 - 1200	800 - 1200	200kA	200kA	2500	L	100kA	100kA	65kA	0.05	100kA	100kA	65kA	65kA				65kA				
G ⁸	1000 - 1200	1000 - 1200	200kA	200kA	2000	L	85kA	85kA	85kA	0.05	85kA	85kA	85kA	-				-				
G	1600 - 2000 (Front Connected TS Only)		200kA	200kA	2500	L	85kA	85kA	85kA	0.05	85kA	85kA	85kA	42kA	36kA		-					
G ⁸	1600 - 2000	1600 - 2000	200kA	200kA	3000	L	200kA	200kA	100kA	0.05	100kA	100kA	100kA	42kA	36kA		42kA	-				
S ⁸	1600 - 2000	1600 - 2000	200kA	200kA	2500	L	100kA	100kA	85kA	0.05	100kA	100kA	85kA	85kA	65kA		85kA	65kA				
G	2600 - 3000	2600 - 3000	200kA	200kA	4000	L	125kA ⁶	125kA ⁶	100kA	0.05	100kA	100kA	100kA	42kA	36kA		42kA	-				
G ⁸	3200	-	200kA	-	4000	L	100kA	100kA	-	0.05	100kA	100kA	-	-				-				
G	4000	4000	200kA	200kA	5000	L	100kA	100kA	100kA	0.05	100kA	100kA	100kA	85kA	65kA		65kA					
U ⁸	2600 - 4000	2600 - 4000	200kA	200kA	5000	L	125kA	125kA	125kA	0.05	125kA	125kA	125kA	100kA				100kA				

Figure 5: ASCO UL1008 Ratings⁸

A review of the ASCO WCR table reflects the hierarchy of the standard. Fused OPDs offer the fastest clearing times and thus the highest short-circuit ratings. Thereafter, "Specific Breaker" and "Time-Based" (time-based) ratings are listed for circuit breakers. Certain switches also offer short time ratings for durations up to 0.5 seconds. These short-time ratings provide flexibility for a comprehensive range of selective coordination schemes. A list of specific breaker ratings for ASCO transfer switches is available in [ASCO Publication 1128](#).



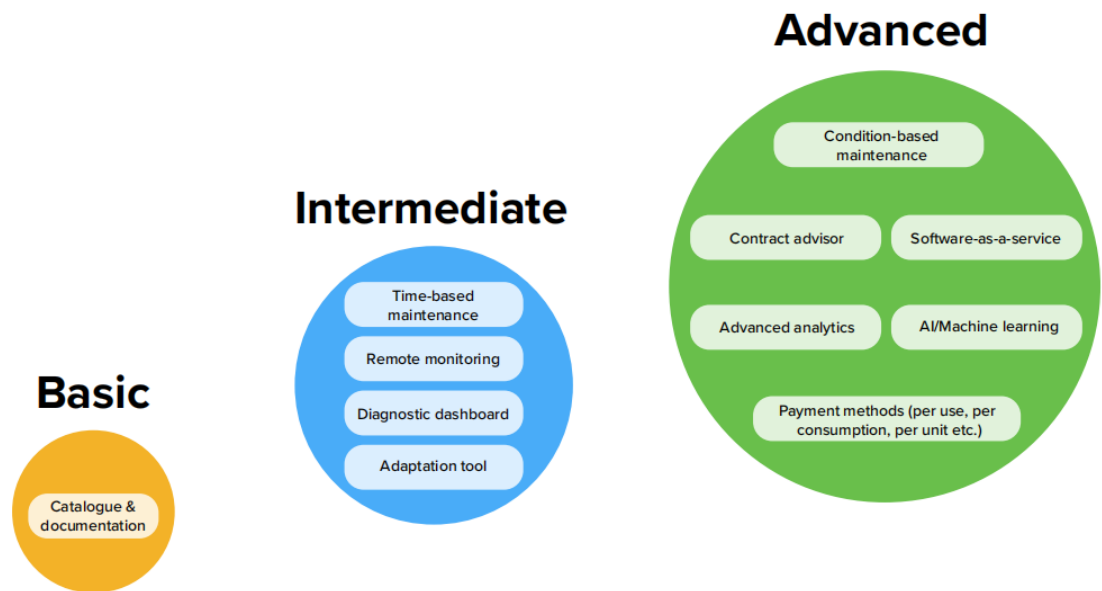
WHAT WOULD BEST DESCRIBE THE STATE OF DIGITAL TRANSFORMATION FOR THE NEXT GENERATION OF MACHINES?



Note: n=174
Source: Omdia

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Nevertheless, survey results shows a divided OEM view when it comes to digital maturity



Source: Schneider Electric

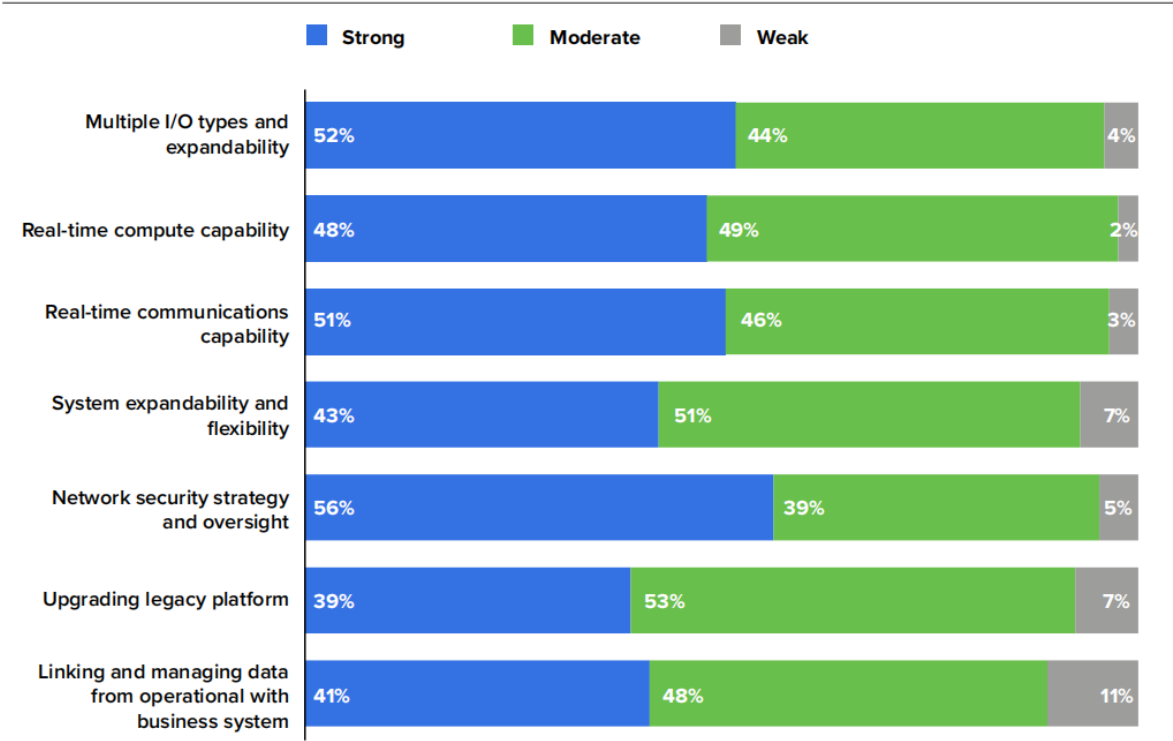
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The following section ranks overall perceived IIoT machine readiness across several parameters.

Upgrading legacy platforms is perceived as the area with lowest IIoT readiness according to OEMs. However, delaying legacy platform upgrades may prove costly as outdated machines become more difficult to maintain and disruptive to operational continuity. Consequently, it is therefore important to ensure continuity of support and that upgraded platforms can offer

System expandability and flexibility is another important aspect that receives comparably low ratings when it comes to IIoT readiness. Legacy systems often have limitations in handling increasing volumes of data and users, and where modernized platforms can scale up or down quickly, and more effectively adjust to demand fluctuations. Ensuring IIoT readiness will remain an important area of focus to the machine builder as it supports risk mitigation associated with the digitalization upgrade.

WHAT IS THE LEVEL OF IIOT READINESS FROM YOUR MACHINE TODAY?



Note: n=174
Source: Omdia

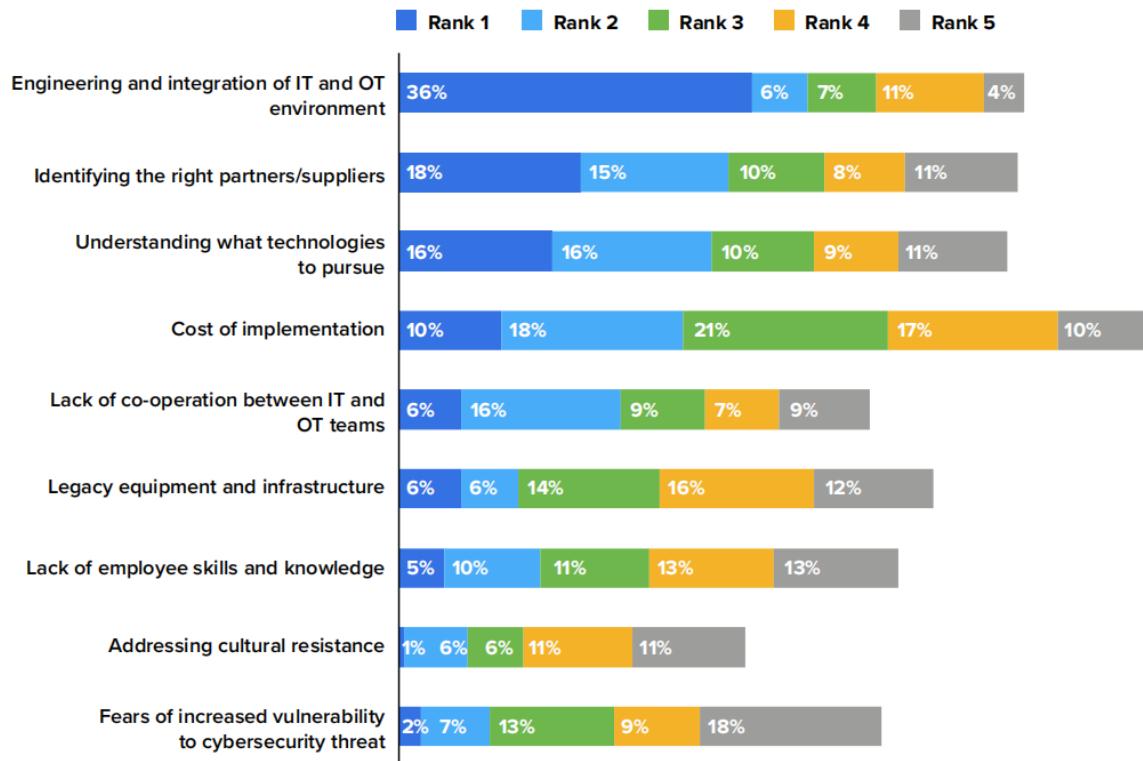
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Real-time compute capability is also perceived as an area with comparably low IIoT readiness from machine. It is important to note that at the IT level, this is not real-time, and it is therefore important to minimise latency between the IT/OT layers.

Most automation systems from machine create data volumes to send to the cloud without significant latency at the field level, which can have costly, and even dangerous, implications. A manufacturer may have hundreds of data points in their automation process that require real or near real-time operations with 99.9% uptime or better. Even a one or two-second delay can cause a costly production shutdown of control systems or compromise the critical information needed for monitoring process performance.

integrating advanced technologies into their digitalisation processes. There is a clear need to better understand machine integration into the IT domain and how to most effectively capitalize on machine lifecycle management solutions.

WHAT ARE THE MAIN CHALLENGES TO INTEGRATING DIGITAL TRANSFORMATION CAPABILITIES WITH YOUR CURRENT TECHNOLOGY PLATFORM?



Note: n=174
Source: Omdia

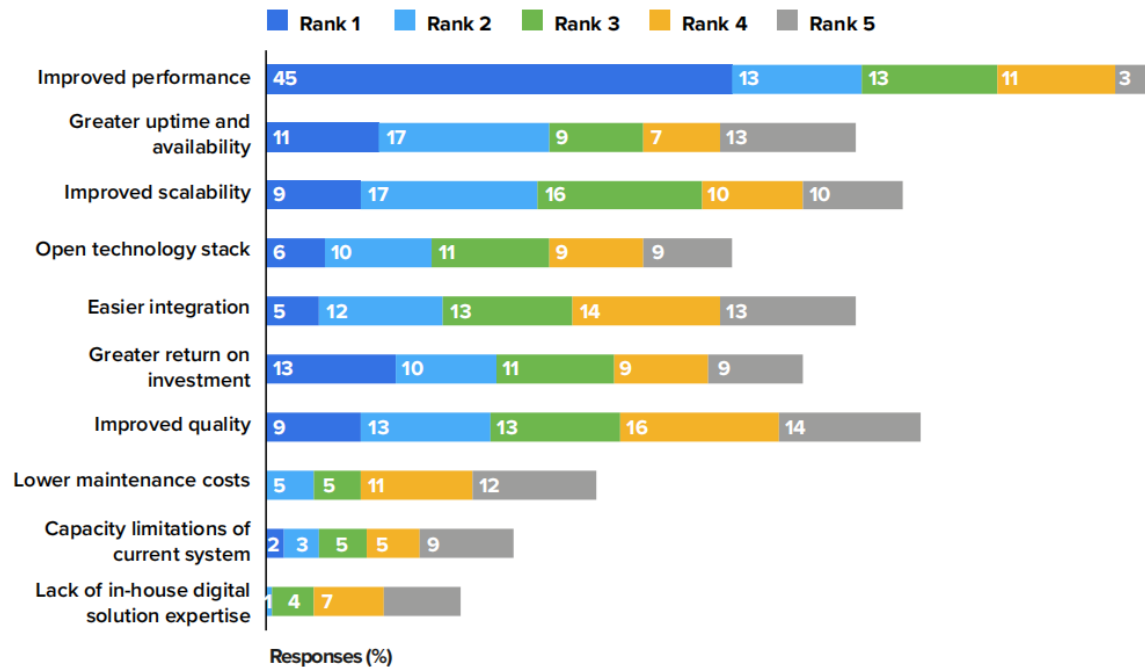
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By accessing more standardised approaches and solutions, there is also added benefit that the cost of implementing and operating machine processes can be reduced, which is also noted a key factor in the study. As this is a considerable upfront investment, OEMs need to carefully plan the budget and develop a strategy that will address and fully respond to their digitalisation needs.

It is also worth noting that the identification of the right partner is perceived as a key challenge

The fact that digital transformation technology enables to further scale such measures, not just at the individual machine level but across product line and enterprise, is further highlighted as a key investment driver among machine builders.

RANK THE MOST IMPORTANT BUSINESS DRIVERS OF IMPLEMENTING DIGITAL TRANSFORMATION TECHNOLOGIES FOR YOUR MACHINE AND MANUFACTURING OPERATIONS?



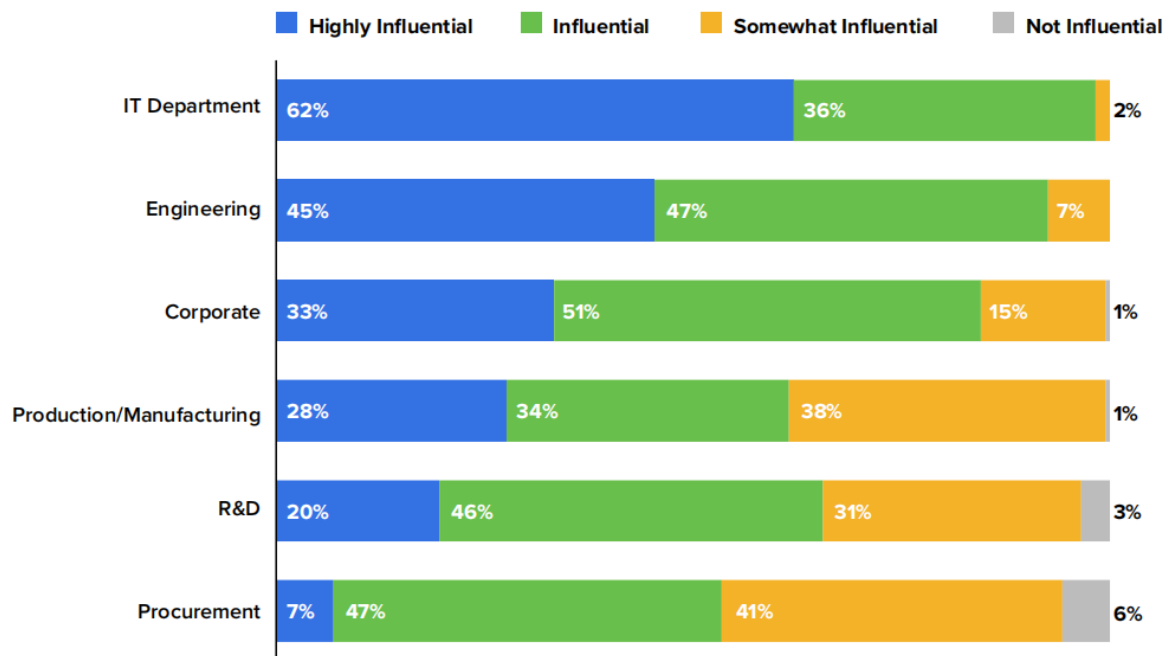
Note: n=174
Source: Omdia

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Other important drivers include but are not limited to -

- Improved uptime and availability
- Greater return on investment
- Improved quality

WITHIN YOUR ORGANISATION, WHAT LEVEL OF INFLUENCE DO EACH OF THE DIFFERENT DEPARTMENTS HAVE WHEN DEFINING DIGITAL TRANSFORMATION SPECIFICATIONS WITH REGARDS TO THE MACHINE LIFE CYCLE?



Note: n=174
Source: Omdia

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Decisions should not be taken in isolation, however, with the survey showing the importance of collaboration between departments including IT and OT. Collaboration between the two is key to untap the potential of the overall machine lifecycle solution, and the IT domain, for example, can advise on how future services can be embedded into the machine.

as real-time data access, predictive maintenance, and remote monitoring.

WHAT THE ARE MOST IMPORT CLOUD-BASED SERVICES THAT A DIGITAL SOLUTION WOULD ENABLE?

